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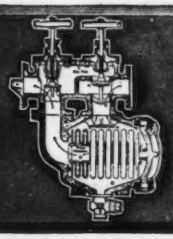

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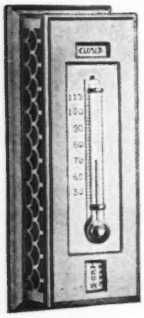

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THE HEATING AND VENTILATING MAGAZINE

Cooperstown, N. Y. DECEMBER, 1916 1123 Broadway, New York

The Testing of House Heating Boilers.

By L. P. BRECKENRIDGE and D. B. PRENTICE.

(Presented at the annual meeting of The American Society of Mechanical Engineers, New York, December 5-8, 1916.)

If all boilers are classified as either power or heating boilers, we define a house heating boiler as one of the latter group designed to serve 2,000 sq. ft. of radiation or less. This is equivalent to a boiler of less than 14.5 H.P. Such a boiler is usually operated with little attention, infrequent firings, low rate of combustion, and automatic pressure regulation by damper control.

The satisfactory testing of house heating boilers by a method which admits of fair comparison is important for three reasons: 1. on account of the increasing cost of anthracite coal it is desirable to determine efficient types of heaters and the most efficient method of burning this fuel; 2. it is desirable to develop efficient types of furnaces for other fuels, such as bituminous coal and coke; 3. by means of standard tests it is desirable to establish a satisfactory rating system which will eliminate the uncertainty of the present manufacturers' ratings of house heating boilers.

REQUIREMENTS IN TESTING HOUSE-HEATING BOILERS.

The authors believe that a method of testing any apparatus to give results of value should meet two requirements:

The apparatus should be tested with as many conditions as possible equivalent to those under which it normally operates (except for particular investigations under special conditions)

Errors should be so far eliminated or reduced that results can be reproduced.

To meet the first requirement with a house-heating boiler it is necessary to operate at a moderate, reasonable pressure, controlled automatically, as would be the condition in an actual installation. It is proper to fire the fuel in rather heavy charges and to give attention to the boiler only at intervals of several hours. The fire should not be frequently shaken or poked. The temperature of the feed water should be comparable to the returns from a radiator system, and the boiler should be supplied with water continuously and uniformly. Perhaps the greatest essential is that the test should be started under average running conditions, with the boiler and covering thoroughly heated to bring the radiation loss to equilibrium, and with a fire neither freshly kindled on bare grates nor clogged with ash; in brief, a good, thin, recently cleaned fire.

The elimination or modification of errors so that results can be verified by several tests presents some difficulties. The measurement of coal fired in the boiler is a matter of careful weighing.

Determining how much coal has been burned is necessarily somewhat uncertain. The method of starting and stopping described later, the authors believe, decreases the error of measurement, yet makes the test under normal running conditions. The low rate of combustion in house boilers and the small amounts of fuel involved make long tests essential. It is necessary to burn at least 40 lbs.

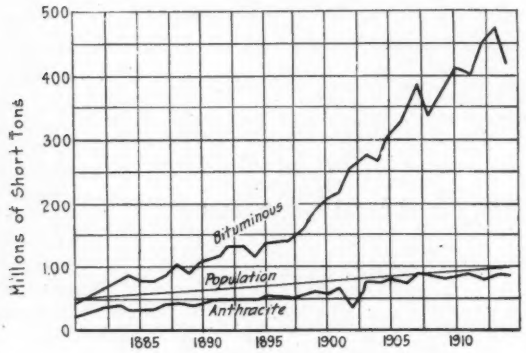


FIG. 1—COAL PRODUCTION IN THE UNITED STATES.

of coal per square foot of grate area, or to test for at least 12 hours, to secure results that can be approximately duplicated. The error in coal measurement is then distributed over an amount large enough to make it a small percentage of the total.

That shorter tests are unreliable is shown by the diagrams of two special tests, Figs. 3 and 4. In these tests, from the start to any one of these endings may be considered a complete test. The evaporation per pound of coal has been calculated for the several periods from the start to the successive closing points, and these performance values are plotted against the elapsed time, that is, the durations of the corresponding periods. The heavy horizontal line represents the average evaporation for the longest period. The vertical distance of any point from this line is the error in the calculated rate of evaporation which would result from closing the test at that time. Very little gain in accuracy is secured by long tests.

CONTROL OF BOILER OUTPUT.

The output of a boiler during a test may be controlled in one of several ways or it may be allowed to vary. The latter condition reproduces, strictly, house operation, where the heating load is uneven, depending on wind and weather. But testing on such a plan would be very unsatisfactory; for the duplication of a test would be a matter of chance, and innumerable experiments might be necessary to produce a performance curve for a fair range of output. Some control is desirable, preferably by a constant and accurate method. Condensation in radiators or piping, the amount of surface that is open to steam being regulated, is too variable. An orifice of some kind is a better control. However, the pressure in the boiler is not even, and the discharge of steam directly through a certain opening would not be uniform.

An excellent arrangement seems to be to maintain a pressure of 2 lbs. per square inch in a receiver by an automatic

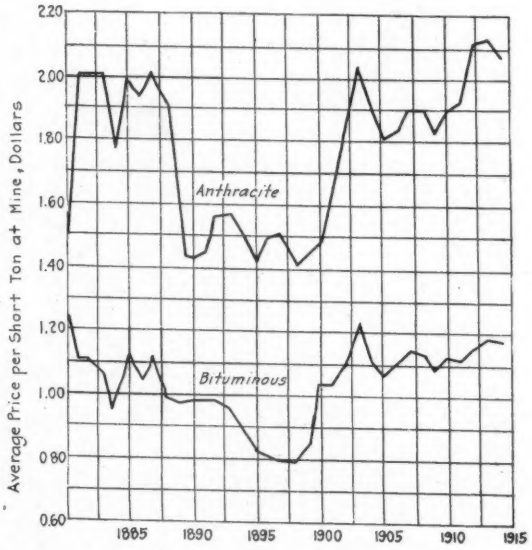


FIG. 2—COAL PRICES AT THE MINES, UNITED STATES.

pressure-reducing valve, the boiler carrying 3 to 8 lbs. The discharge from the receiver through a given area is then constant. The authors believe that a tapering needle valve is more satisfactory than a set of changeable orifices, as it facilitates varying the load during operation. A bank of valves of varying size, opening from the receiver, is another convenient and suitable method of control. The exhaust steam may be used to warm

the feed water or it may be condensed and used again.

The method of feeding the water to the boiler is not important provided a steady, easily controlled flow is secured. The measurement of boiler output may be made either before or after the water goes to the boiler. An extremely convenient method is to draw the water supply from a tank fitted with a long gage glass and scale. The level is quickly noted and no "weighing back" is necessary. The tank should be carefully calibrated, by weighing, over the entire range between the extreme levels reached. A duplex water-driven pump is a very convenient device for feeding the boiler wherever city water pressure is available.

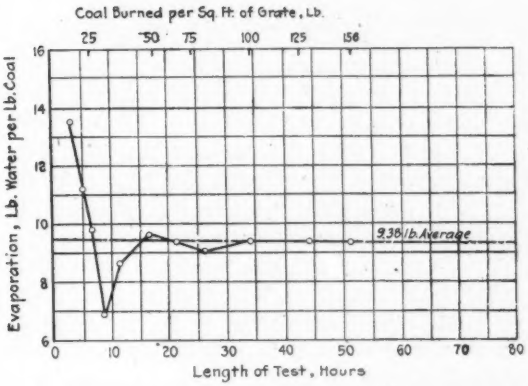


FIG. 3—SPECIAL TEST TO DETERMINE PROPER LENGTH OF HEATING BOILER TESTS.

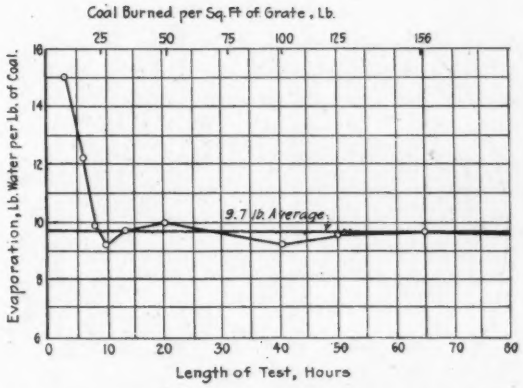


FIG. 4—SPECIAL TEST TO DETERMINE PROPER LENGTH OF HEATING BOILER TESTS.

METHOD OF STARTING TESTS OF HOUSE-HEATING BOILERS.

The authors have found the following method for starting house-heating boiler tests very satisfactory. A preliminary fire is carried until the boiler is well heated and operating at the usual pressure, about 5 lbs. and the load at which the test is to be made. When conditions are considered stable, the preliminary fire is allowed to burn down, the pressure begins to fall, and the fire is shaken, which retards the pressure drop temporarily; but soon a pronounced fall is noticed. The fire is now thin, clean, burned-out, but still hot enough to kindle fresh fuel. When the pressure reaches a given point, perhaps 3 lbs., the necessary measurements are made, including a careful determination of the thickness of the fuel bed, the first charge of weighed coal is fired, and the test is considered started.

When the test is drawing to a close these same conditions are readily duplicated, and at a point, after shaking, when the pressure falls to 3 lbs., the test is concluded. The ash should be shaken out until the thickness of the fuel bed is the same as at the start. The events outlined are characteristic, and a recording pressure gage pictures them very clearly.

The accompanying diagram, Fig. 5, was copied from a pressure chart made during an actual test. The periods of falling pressure immediately before the beginning and ending of the test, as well as before each firing, are quite distinct.

PROPOSED UNIT OF CAPACITY FOR RADIATORS AND HEATING BOILERS.

The capacity or commercial rating of a heating boiler has always been given in terms of the direct radiating surface which it would serve. The unit usually employed is the "foot of radiation," commonly understood to be that surface which will condense a quarter of a pound of steam per hour at 2 lbs. pressure when in still air at 70° F. Originally the foot of radiation meant a square foot of radiating surface, but improvements in design and arrangement enabled manufacturers to secure this condensation with less surface, and consequently less weight of iron. The result has been a

variable and decreasing value in square inches for the "foot of radiation." In fact, the unit has become, as it should, dependent entirely on condensation of steam, which means a heat transfer, rather than on any particular area of metal.

If the unit is considered as a certain number of heat units it is applicable to boilers directly, as well as to radiation. There are many reasons why it would be convenient to have a capacity unit for heating boilers comparable to the capacity unit for power boilers, *i.e.*, the boiler horsepower. The authors propose, therefore, the following definition of a unit for stating the capacity of radiators and heating boilers:

The "foot of radiation" shall be a

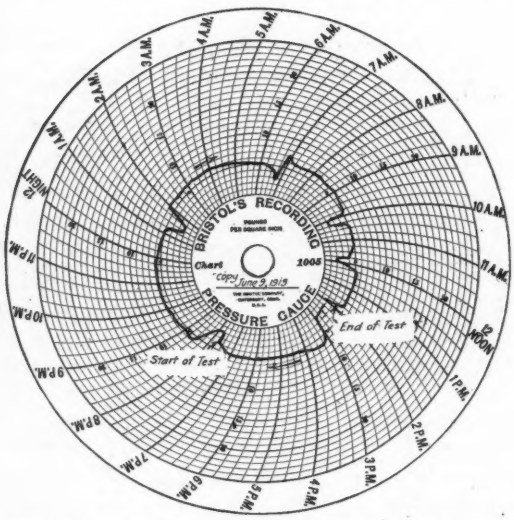


FIG. 5—PRESSURE CHART MADE DURING AN ACTUAL TEST OF A HOUSE HEATING BOILER.

quarter of a pound of steam condensed from and at 212° F. per hour.

This is equivalent to a heat transfer of 242.6 B.T.U. The condensation of a quarter of a pound of steam at 2 lbs. pressure is equivalent to 241.5 B.T.U. There is, therefore, very little change in the heat equivalent of the unit. Although there is no direct connection between the unit as defined above and a square foot or any particular area of radiating surface, yet the authors favor the retention of the old name for the same reason that boiler horsepower was continued, although that unit bears no relation to the standard horsepower.

The advantages of the above definition of the "foot of radiation" are:

The heating and power-boiler capacity units are based on the same physical conditions.

They are mutually convertible by the factor 138.

Radiation is rated without reference to surface, so that efficient designs and arrangements are benefited.

The unit is applicable to hot-water radiators and heaters by determining the heat transfer. (The result may be called "equivalent feet of radiation.")

The authors recommend that radiator tests to determine rating be made with steam at 2 lbs. pressure and in "still air" at 70° F., and suggest that boilers under test be operated at from 3 to 8 lbs. pressure.

PROPOSED HOUSE-HEATING BOILER CODE.

[The paper proceeds to give the proposed individual code for house-heating boilers to be used in conjunction with the First Section (General Matters) of the Report of the Power Test Committee of the American Society of Mechanical Engineers. This code follows closely the A.S.M.E. boiler code of 1915, differing materially only in the paragraphs dealing with the duration of tests, the method of starting and stopping tests, and the calculation of results. These paragraphs are given below.]

DURATION.

The duration of tests to determine the efficiency of a house-heating boiler should be at least 12 hours of continuous running, or such time as may be required to burn a total of 40 lbs. of fuel per square foot of grate. The duration of tests which include periods of banked fires should not be less than 24 hours. The duration of tests to determine the maximum evaporative capacity of a boiler without determining the efficiency should not be less than 3 hours.

STARTING AND STOPPING.

The conditions regarding the temperature of the furnace and boiler, the quantity and quality of the live fuel and ash on the grates, the water level, and the steam pressure, should be as nearly as

possible the same at the end as at the beginning of the test.

To secure the desired equality of conditions the following method should be employed:

The furnace should be well heated by a preliminary run of at least an hour under all the conditions at which it is proposed to test. A suitable pressure for running the boiler while under test is from 5 to 8 lbs. During this run the operation of the pressure-reducing valve and damper control should be tested, and the setting of the output-control valve should be verified. The fire should now be allowed to burn low, which will result in a falling pressure. When the pressure reaches a chosen point (3 lbs. is recommended), the fire should be shaken clear of ash, the thickness of fuel bed noted, the water levels in boiler and feed tank recorded, together with steam pressure, draft, flue temperature and the other usual data. The first charge of weighed fuel should now be fired and the time recorded as the starting time for the test. The test should be ended when the fire has burned low and it is impossible to check the pressure fall by shaking, as at the start.

When the pressure again reaches the chosen point the final readings should be made, the ash shaken out until the fire is the same thickness as at the start, and the time recorded as the stopping time. It is advisable to regulate the feed so that the water in the boiler is brought to the starting level and held there, toward the end of the test. All ash should be removed from the ashpit immediately after the fire is shaken down at the beginning of the test and again at the end. The second lot, with any that may have been drawn during the test, should be carefully weighed.

CALCULATION OF RESULTS.

The method to be followed in expressing and calculating those results which are not self-evident or stated in detail in the Boiler Code of the A.S.M.E. is as follows:

The capacity of the boiler in "feet of radiation" served is found by dividing by 242.6, the total heat absorbed per hour by the water in the boiler, expressed in B.T.U.

Standard Practice in Sheet Metal Work for Ventilation Systems.

WITH SUGGESTIONS FOR A COMPLETE SET OF SPECIFICATIONS.

By T. W. REYNOLDS.

The variations in practice that now exist for the construction of ventilating ducts make desirable a discussion of the question with a view to perfecting a method which may be universally referred to as good practice. Speaking generally, no more trying situation can be created than when the engineer is called upon to approve and accept the usual system as installed by the contractor. How many of these systems are durable and efficient, presenting a minimum of friction losses and leakage and in how many is the distribution of air to the various outlets ever effected in the proper proportions?

All contractors, in common with engineers, evince the same symptoms under the same circumstances. However, there are engineers and contractors possessing individualities all their own, and when an engineer designs a perfect system as seen by himself, he is obstructed by the views of the contractor who installs the system in accordance with his own opinion and as conservatively influenced by his own economy. Often a system is installed improperly due to failure upon the part of the contractor to grasp what is desired by the engineer. The contractor is not an engineer nor is he expected to be, but nevertheless he often becomes a good one, due to his familiarity with standard practice and good judgment based upon practical experience. The contractor, however, tends to construct his work along the lines of least resist-

ance, that is to say, along the lines with which he is most familiar, and anything divergent therefrom is viewed with suspicion.

DUCTS IN GENERAL.

Should the reader care to accept and adopt the statements made herein and embody the same in his standard specifications, he may readily do so as the remainder of this article has been arranged in a modified specification form. We will all agree that ducts should be substantially constructed of sheet iron, well stiffened and braced. Preferably these are of galvanized iron dependent somewhat upon durability and existing economy as weighed in the balance.

The writer specifies ducts of a thickness not less than those given in the following table:

Up to 20 in. wide .....No. 24
21 in. to 29 in. .....No. 22
30 in. to 39 in. .....No. 20
40 in. and upwards .....No. 20
braced with angle iron.

Metal exposed to the weather should be two gauges heavier than the above with all stops, sleeves and filling in pieces constructed of No. 24 galvanized iron. These gauges are either U.S.S. or B.S.W. gauge and by wide is meant the longest dimensions. It is, however, quite a common practice for the contractor to construct the short vertical sides of main trunk ducts with metal of a lighter gauge than that forming the top and bottom thereof. The feasibility of this construction is dependent somewhat upon the method of supporting the ducts, whether hung by metal strips attached directly to the upper sheet or by the carrying of these under and around the sides of the ducts.

There is also much which might be said regarding the making of joints across the width of the ducts or running parallel with the same, as well as on the selection of ducts of a size favorable to quick construction and a minimum of labor with a corresponding receipt of a lower bid, this where the intentions upon the part of the bidder are to follow out the dimensions as shown upon the plans.

Joints should be smooth inside the ducts with bracing so arranged as not to interfere with the free flow of air along the ducts. These should be sufficiently strong so as to permit of a man passing along for cleaning. It is advisable to avoid the passing of piping or conduit for wiring through the ducts or otherwise obstructing the same.

Ducts should be constructed and arranged so as to permit of their being readily cleaned. They should be carefully made tight, in particular the exhaust ducts, so that a hose can be used inside without leakage or damage to other work. The latter stipulation permits of no argument as regards the tightness of the metal work and will tend to insure the construction of a good installation.

All metal work in hung ceilings, dead or furred down spaces should of course be erected in time so as to occasion no delay to the other work in hand.

It is well to fit doors and manholes for access to the interior of the ducts wherever necessary. Also a design which has been given the proper consideration will be arranged so as to clear the plumbing and other pipes, this applies to all ducts, flues, access doors and volume dampers.

ERECTION OF DUCTS.

When finished, the sheets of galvanized iron work should be fair and free from buckling and sagging. All seams, joints, and connections to brickwork, plaster, concrete or terra-cotta should be air-tight. All round pipes should be heavily beaded, riveted and soldered if necessary to make them tight. Reserve the right to order any pipe riveted and soldered at any seam if the pipe is not made tight in erecting. Construct vertical ducts or risers so as to be self-supporting, complete in themselves, and allow no single thickness partitions between ducts.

All ducts should be substantially supported with wrought iron hangers to the ceiling or otherwise, depending upon local conditions, placing supports not over six or eight feet apart along the length of the duct. Make all hangers of 1 in. wide galvanized iron, No. 16 gauge

and rivet or bolt hangers to sides of the ducts. The upper ends of hangers may be firmly secured to the ceiling slab or to concrete beams by means of expansion bolts. The same method of procedure should be practically followed out in the erection of vertical ducts and flues. Wood plugs driven into masonry should not be approved, nor should nails, wires and cotter pins be run through the ducts. Similarly the punching of holes in any way in ducts to aid in their erection should not be tolerated. If this is done, new sheet metal should be furnished and erected by the party responsible for such conditions. Stipulate that all necessary hangers, braces, tees, angles and supports for the ducts should be provided and secured in a satisfactory manner.

Carefully close all ducts and register openings during construction. This is not always done. Remove all dirt and rubbish, from around and between the Vento heater sections the last thing before the galvanized work is begun and at the completion of the work remove all dirt, debris and rubbish from, in and about the air chambers, heater sections, ducts, register faces, louvres, screens, etc., and wash all ducts, dampers, diffusers, register faces, louvres, etc. with a damp cloth or sponge.

To avoid baffling air currents construct all bends, tees, and elbows in air ducts with easy turns with bends having a radius not less than the diameter or width of the duct. Where ducts are reduced in area, such reduction should be gradual, all sharp edges and corners being avoided. Use sweeps in all ducts where there is a change in direction of the flow of air.

A good practice is to make up ducts with *standing seams having separate cleats mitering at the corners, as shown in the diagrams below.*

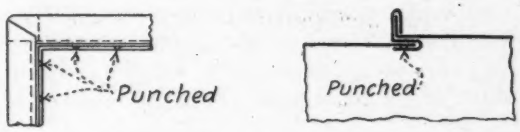
Do not approve ductwork having joints open at the corners. Permit lock seams only in vertical pipes.

On all ducts intended to be covered with insulating material, specify standing seams having a projection not more than three-quarters of an inch from the sides of the duct and with 3/16 in. holes punched 5 in. center to center.

Use asbestos cement for caulking joints to make them tight. Wherever iron ducts terminate in concrete, brick or masonry openings, make tight joints by means of closely fitting heavy flanged iron collars.

DOORS.

Approve the design of metallic doors and set these wherever necessary for access to the interior of the air ducts and to dampers, deflectors, heaters, valves, etc., in the air chambers and ducts. All doors should be of the pan type, large sizes being suitably stiffened with angles and opening in such a way as to be kept closed by air pressure. All doors should be strong, rigid, tight and provided with galvanized iron hinges with turned brass pins and heavy latches. Frames for doors should be of iron construction. Doors for access to main air ducts should be constructed of No. 14 gauge steel plate, suitably stiffened with angle iron frames and provided with a substantial hasp and padlock. Any ladders required for access to doors, interior of ducts and to deflectors in same should be furnished.



APPROVED PRACTICE FOR MAKING SEAMS IN DUCTS.

DAMPERS AND DEFLECTORS.

Each end of a damper or deflector shaft should be supported in a cast iron bearing, one end may be supported by the quadrant which should be provided for indicating the position of each damper or deflector, and the other end by a bearing fastened to the side of duct. It is advisable to approve a sample before proceeding with the work.

At all junctions of ducts or places where air currents divide, fit deflectors consisting of stout galvanized iron sheets. In small ducts under 12 in. depth these sheets can be fixed approximately in position and bent for final adjustment. In larger ducts these deflect-

ors should be of galvanized iron, not less than No. 14 gauge secured along one edge to a substantial 5/8 in. round wrought iron axis working in cast iron bushings attached to sides of duct and provided with set screws for permanently locking the deflector in required position.

Provide a hand hole for access to each deflector. Where cleanout doors are close enough to dampers or deflectors for adjusting same, the hand hole may be omitted. Hand holes may be used to great advantage when finally adjusting the system, the necessary adjustments may be facilitated and the system quickly balanced if intelligently designed, by the manipulation of dampers or deflectors through these hand holes. The general tendency is to leave out either or both hand holes and deflectors even though clearly specified and shown. The exact position of a damper or deflector may be quickly ascertained and may be more accurately known where hand holes have been installed adjacent thereto.

All points where it is necessary to take off supply or exhaust branches at right angles to vertical air ducts or where openings for air occur in the sides of such ducts should be fitted with substantial galvanized partitions inside of duct carried back as directed from point of division, with hand hole in main duct for access, and arranged so as to divert a greater or less amount of air to the branch as may be required.

Provide means for permanently adjusting the ends of division plates in the required positions.

Place a stop damper in the discharge duct of each fan for closing the duct when the fan is not in operation. These dampers should be fitted with quadrants or chains so that they may also be set to regulate the fan discharge and pressure when open. These dampers should work easily and should be mounted on a turned shaft supported by two brass bearings attached to the duct.

The fresh air inlet to the fan should be equipped with movable steel louvres or other approved dampers for completely closing the inlet when required. These louvres should be constructed of 3/16 in. steel plates erected in steel channel frames with connecting rods and operating devices as shown on an approved detail. They should close weather tight on felt strips and should have suitable means for locking in any desired position.

Install fixed louvres to prevent the entrance of rain and snow through discharge openings.

All the above dampers should be of double thickness No. 16 gauge galvanized sheet steel.

It is sometimes the practice to place a volume damper back of each exhaust register face. The control for such dampers should be located back of the register face. Properly adjust these dampers for the flow of air before the register faces are set.

All dampers should be of heavy pattern with large sizes suitably stiffened with angles. They should be made strong, rigid, fitted tightly and provided with angle iron stops if necessary, the design, method of hanging and control being suitable for the location and service required.

All dampers should be provided with suitable chains, catch plates or quadrants as required.

Construct diffusers of substantial galvanized iron in supply register openings wherever necessary. They should be fitted inside of register faces and be painted a dark color so as not to be readily visible, or they may be painted in accordance with the local color scheme. In the opinion of the writer the last is the best method for rendering them least conspicuous.

REGISTER FACES.

Install wood frames in the walls for fastening the register faces to.

The ducts should be brought through the walls and openings left of a size as marked on the plans, the dimensions being as given in a standard catalogue. The contractor is advised to make up the register boxes on the job so as to conform with structural conditions existing at the time of installation.

Special importance should be attached to the manner in which the exhaust register boxes are made up; they should perfectly fit the register frame and face,

so as to be free from pockets in which water or dirt may collect.

Register faces and grilles should be put in place after the building and ducts have been cleaned but before the walls have been painted.

The dimensions given on the drawings refer to the inside dimensions of the opening. Where they are required to be placed in a vertical plane, showing one projection only in plan, the horizontal dimension is indicated first followed by the vertical dimension. All dimensions should be verified at the building.

"Reg" or "R" indicates register with movable louvres.

"Reg. Face" or "R.F." indicates register face without movable louvres, same to be clear of wheel space and screw holes.

"Grille" or "G" indicates wrought iron wire grille.

"B" and "T" prefixed to above indicates bottom or top position, bottom position being taken to mean near floor and top position in side wall with bottom of face usually 8 ft. 0 in. above floor, unless otherwise indicated on the drawings.

"Clg" prefixed to above indicates same is to be placed in the ceiling in a horizontal plane.

Register faces are of cast iron or bronze as required and are usually of the plain lattice pattern though many other designs are readily obtainable. They may be of the "Sanitary" pattern having openings in the face in the form of vertical slots full height of the same, or they may be of cut steel No. 12 gauge with ⅞ in. by ⅞ in. openings having a net air space of not less than 65% of the face. These latter can be furnished with diagonal mesh if desired and with ½ in. by ½ in. openings. In some instances it is desirable where registers are placed six feet or more above the floor to furnish the same with operating cords, brass or nickel-plated brass chains and required pulley attachments, the ends to be fitted with suitable indicator handles marked "open" and "shut." These may be finished in a variety of ways, in Japan, bronze, plated brass, bronze or nickel, or in solid brass or bronze. Registers of the locking type are usually of the key operating type, if hand operation is desired use a wheel. Floor registers are fitted with floor borders of the same material as the register and under each register face a screen is placed made of ¼ in. galvanized iron wire bound over a round wire frame, and painted black. For the foot warmer stacks, the warm air opening is covered with a register and the cold or return air opening with a register face.

Register faces used for enclosed radiators should have, where required, a small section of the net-work formed as a secret hinged door, approximately 6 in. by 6 in. in size, and properly located opposite each control valve of the radiator.

Register faces for hinged cast faces should each be furnished with angle iron frame to which the face should be hinged with two butt hinged on one side and a knob catch at the opposite side, use a key lock if desired.

Woven wire grilles are made of No. 10 gauge round iron wire of 1½ in. x 2½ in. diamond mesh spread in ¾ in. channel iron frame, with 1½ in. x 1½ in. x ⅛ in. angle iron border having mitred and brazed joints at corners. Borders should be securely fastened to the wood grounds, using countersunk wood screws so placed as to be as inconspicuous as possible. Grilles located in side walls should have the long dimension of the mesh placed in a vertical position. Woven grilles are also made of flat strips of 5/16 in. x 1/16 in. iron arranged in square mesh, spaced 1¾ in. center to center of strips.

All exhaust grilles should have the channel iron frame hinged to the border using two butt hinges on one side with approved lock and guard on opposite side, the same key to fit all locks.

The fresh air supply grilles should be furnished without hinges, the channel iron frame being attached to the border with machine screws accessible for removal if required.

Registers and register faces set in brick, terra cotta or concrete walls should be furnished with heavy cast iron wall frames. Where placed in metal lath and plaster partitions or ceilings, they should be fitted with 2 in. deep band iron

frames, suitable for attachment of the registers or faces.

Each outside air intake window or opening should be provided with a heavy wire screen or guard made of No. 8 gauge round iron wire of 1½ in. x 2½ in. diamond mesh spread in ¾ in. channel iron frame, the frame should be securely attached by screws to the jamb of the opening.

Back of each guard attach a galvanized preferably copper iron wire screen of ¼ in. square mesh on suitable galvanized iron frame.

Guards should be painted or black enameled at the factory before shipment and repainted after erection.

The woven wire grilles for room openings should be bronzed or electroplated at the factory of finish as desired.

Registers and register faces should be painted a flat coat of best lead, zinc and oil paint at the factory, ready for final painting after erection.

ROOM OUTLET CONNECTIONS AND CASINGS FOR VENTO HEATERS.

Each fresh air inlet to room opening should have the flue extended and stopped 8 in. above the room opening, forming an air cushion to equalize the flow of air through opening. Each exhaust air outlet back of room opening should have the flue formed as a curved deflector.

From the fresh air chamber around the Vento stacks and by-pass up to the suction of the supply fan, erect casings of No. 18 gauge galvanized iron thoroughly stiffened with 1½ in. x 1½ in. angle iron braces and fitted with all necessary doors to give access to all parts of the apparatus, doors to be not less than 24 in. x 30 in. in size, constructed as hereinbefore mentioned. The casing around the heater should be made in sections so that it can be readily removed without the breaking of pipe connections, and to permit of access to the heaters.

Provide doors with locks and keys.

The Vento stack casings arranged for gravity supply should be constructed of No. 22 gauge galvanized iron using double lock standing seams, they should be substantially supported and put together with the stack strips and bolts in such a manner as to be readily removed without breaking pipe connections and to permit access to the heaters. Casings should be of double construction which allows for the insertion of ½ in., 85% magnesia blocks. At the side or end of each stack casing provide two heavy 8 in. x 12 in. swinging clean-out doors with suitable catch plate placed in a convenient position. Install one of these doors near the bottom of the casing, the other near the top. The air space over and below the indirect radiators should not be less than 12 inches.

COVERING.

Cover all warm air supply flues in pipe chambers and in suspended ceilings with corrugated asbestocel paper ¼ in. thick securely wired on.

The main warm air supply ducts in the basement should be covered with ½ in. asbestos sheets throughout their entire length. If further consideration need be given to appearance, an 8-oz. canvas jacket may be pasted on this surface.

The casing of vento heaters should be covered with 85% magnesia blocks 1 in. thick wired on, and finished with ½ in. of hard finishing plaster.

PAINTING.

Paint all sheet metal work in pipe chambers and chases. Paint all canvassed duct coverings one coat of glue size, after which apply two coats of best lead and oil paint of color as selected. Paint all uncanvassed sheet metal work as above but omit the glue size. Where lead and oil paint is used, a glue size must first be applied, as otherwise the lead and oil will sink into the insulating material, lessening its efficiency and losing the effect of the paint.

Galvanized iron work where exposed to the weather should be painted two coats of Goheen's "Galvanum" or equal approved paint of color selected.

Register faces should be painted a white flat paint by the manufacturer, suitable for receiving a priming coat by the owner, and as directed by the architect.

Paint all galvanized iron work, masonry, or woodwork exposed to view back of register faces, two coats of "Chrysolite" or equal approved black paint with dull finish as directed by the architect.

Paint the curved galvanized iron deflectors in top of fresh air inlet flues two coats of lead and oil paint of color to match finish of adjacent walls as directed by the architect.

Paint all exposed iron work, pipe, fittings, hangers, etc. two coats of No. 500 Minwax or equal black paint as approved by the architect.

Also paint castings and equipment in the same manner.

The ventilators, shutters, louvres, etc., should be painted after erection two coats of Goheen's "Galvanum" or lead and oil paint as approved and of colors directed by the architect.

Speed Control of Direct-Current Motors in Ventilating Service.

By B. N. STRADER.

Westinghouse Electric and Manufacturing Company.

When the speed of a ventilating fan or blower driven by a direct-current motor must be varied, the question at once arises what method of changing the motor speed should be used. The answer is not a simple one to arrive at, for there are several alternative methods of speed control, and both the first cost of the motor and its cost of operation must be taken into consideration. To supply the data necessary to answer this question is the purpose of this article.

As is well known, there are three methods of speed control for a direct-current motor.

1. Field Control: That is, increasing the rated speed of the motor by inserting resistance in series with the shunt field.
2. Armature control: That is, decreasing the rated speed of the motor by inserting resistance in series with the motor armature.
3. A combination of the two: That is, obtaining speeds below the rated value by armature control and above the rated value by field control, thus giving a very wide range.

Where field control is used it is commonly and correctly spoken of as "increase in speed by field control." However, to make a more uniform basis of operation, it will be dealt with as "reduction in speed" in this article, it being understood that the motor is based upon the maximum horsepower at the maximum speed.

FIELD CONTROL METHOD.

The first or field control method is the most economical from the power consumption point of view and is very satisfactory within the stable operating limits of the motor. Where a large reduction in speed is required, a more expensive motor design is necessary than would be used for armature or combination armature and field control.

ARMATURE CONTROL METHOD.

The second method, *viz.*, armature or rheostatic control, is wasteful in that an appreciable amount of power is consumed in the control resistance. This is a dead loss and at first sight appears to put armature control method out of the question when compared with the field control method. However, as a fan load drops off so rapidly (varying approximately as the cube of the speed) these losses are not comparable with those which would occur in a case where the load is proportional directly with the speed. With an average motor carrying a fan load these rheostatic losses do not exceed 19.2% of the motor input at full load under the worst conditions which occur at approximately 57% full load speed. Here the external losses reach a maximum.

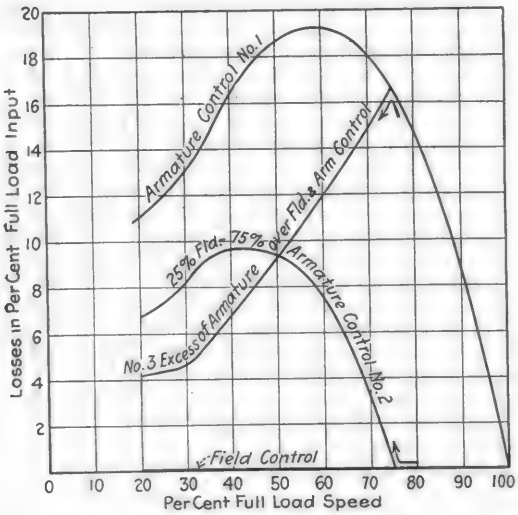

Losses in Per Cent Full Load Input
Per Cent Full Load Speed
Armature Control No.1
25% Fld.-75% Arm Control
No.3 Excess of Armature
Armature Control No.2
Field Control

FIG. 1—CONTROL LOSSES OF MOTOR DRIVING CENTRIFUGAL FAN.

ADVANTAGES OF A COMBINATION OF FIELD AND ARMATURE CONTROL.

The third or combination of armature and field control method represents a conservative compromise between the other two methods where the speed variation by field control is slightly greater than the normal variation permitted by the design of the motor. The first part of reduction is effected by field variation, and the second part by armature control. Here it is possible to get the desired range of speed with a less expensive motor than if straight field control method were used and, at the same time, the operating expenses are reduced over the straight rheostatic or armature control. By using field control for the first 25% of the speed reduction and armature control for the last part, the external losses do not exceed 9.7% of the field load input, and this maximum value occurs at approximately 43% of the full load speed.

Fig. 1 shows approximately these losses in percentage of full load input over working speed range. By reference to these curves it will be seen that the maximum loss with a combination method is approximately one-half of the maximum loss with the straight armature control, and that the losses of the latter method are approximately 16½% when the losses of the combination method begin. Curve 3, Fig. 3, shows that the amount (in percentage) in losses with straight armature control exceed those of the combination method. It will be observed that the losses are all on a percentage of full load input basis.

Curves in Fig. 2 show the cost of power per year to operate a motor requiring 10 K.W. input at full load speed, based upon a power cost of 1c per K.W. hour, for simplicity in calculation, running 10 hours per day 365 days per year. The power costs to operate any other motor are in proportion to the full load input of the motor in question to 10 K.W.

Example: Assume 25 H.P. motor 86½% efficiency full load input $= \frac{25 \times 0.746}{86.5} = 21.6$ K.W.

At 80% speed the cost per year to operate the 10 K.W. input motor as taken from curves 1, 2 and 3, Fig. 2:

Armature control	$264.00
Field control	214.75
Field and armature control	214.75

The cost per year to operate the 25 H.P. motor is:

$\frac{21.6 \times 264}{10} = \$570.00$ with armature control.

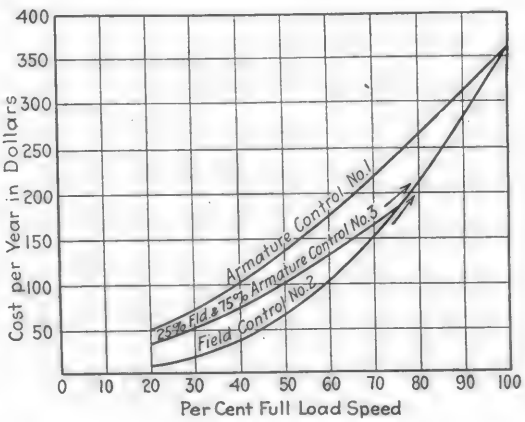


FIG. 2—OPERATING COST OF 10 K.W. MOTOR (INPUT), DRIVING CENTRIFUGAL FAN.

(Cost of power taken at 1 cent per k.w. hr.)

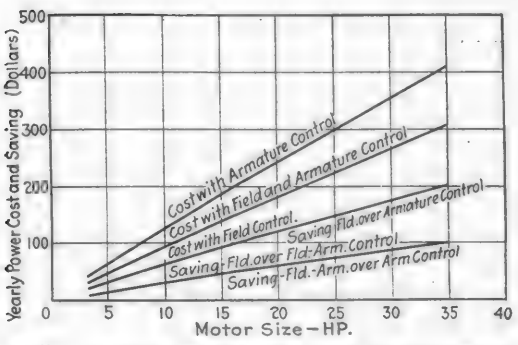


FIG. 3—YEARLY POWER COST AND SAVING WITH DIFFERENT CONTROL METHODS.

(Motors running 10 hrs. per day at 50% speed.)

$\frac{21.6 \times 214.75}{10} = \$463.50$ with field control.

$\frac{21.6 \times 214.75}{10} = \$463.50$ with armature and field control.

Yearly saving with field or armature and field control over armature control at this speed will be \$570.00 — \$463.50 = \$106.50.

At 50% speed the costs to operate the 10 H.P. input motor as taken from curves 1, 2 and 3, Fig. 2 are:

Armature control	\$137.00
Field control	68.50
Field and armature control	102.00

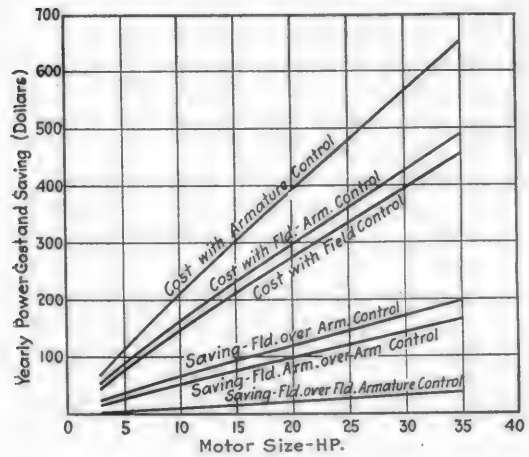


FIG. 4—YEARLY POWER COST AND SAVING WITH DIFFERENT CONTROL METHODS.

(Motors running 10 hrs. per day at 70% speed.)

$\frac{21.6 \times 137}{10} = \$296.00$ with armature control.

$\frac{21.6 \times 102}{10} = \$221.00$ combination armature and field control.

$\frac{21.6 \times 68.5}{10} = \$148.00$ with field control.

The yearly saving is:

\$296.00 — \$148.00 = \$148.00 field over armature.

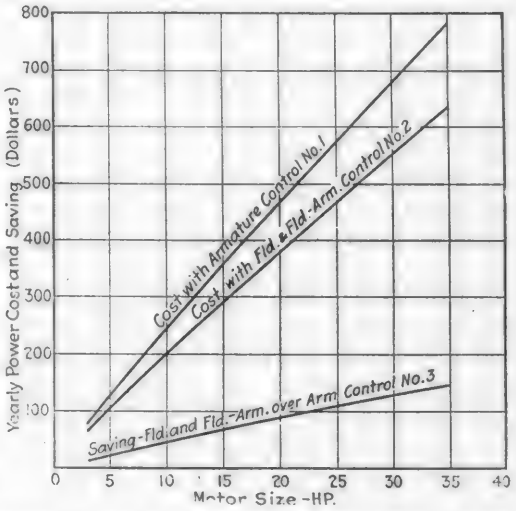


FIG. 5—YEARLY POWER COST AND SAVING WITH DIFFERENT CONTROL METHODS FOR MOTORS DRIVING CENTRIFUGAL FANS.

(Motors running 10 hrs. per day at 80% speed.)

\$221.00 — \$148.00 = \$73.00 field over combination.

\$296.00 — \$221.00 = \$75.00 combination over armature.

The yearly power costs in saving are plotted in Figs. 3, 4 and 5 for motors from 3 H.P. to 35 H.P., for 50, 70 and 80% of full load speed, respectively. In like manner a set of curves can be plotted for any percent. speed reduction allowing the proper motor efficiency in each case, and the yearly saving in power costs of one method over the other is obtainable by subtraction.

APPROXIMATE INITIAL COST OF 400 R.P.M. MOTORS FOR THE THREE CONTROL METHODS.

Prices do not include controllers.

H.P.	Max. Speed R.P.M.	50% Reduction Armature only	25% Field 25% Armature Reduction	50% Field Reduction	Cost Armature and Field over Armature	Cost Field over Armature	Cost Field over Armature and Field
3	400	$205.00	$240.00	$ 280.00	$ 35.00	$ 75.00	$ 40.00
5	400	270.00	305.00	345.00	35.00	75.00	40.00
10	400	380.00	440.00	490.00	60.00	110.00	50.00
15	400	502.00	587.00	640.00	85.00	138.00	53.00
25	400	660.00	755.00	865.00	95.00	205.00	110.00
30	400	720.00	830.00	950.00	110.00	230.00	120.00
35	400	775.00	890.00	1,035.00	115.00	260.00	145.00

YEARLY SAVINGS IN POWER COST AT 50% SPEED.

		Cost			Savings		
H.P.	Max. Speed R.P.M.	50% Reduction Armature only	25% Field 25% Armature Reduction	50% Field Reduction	Field and Armature over Armature	Field over Armature	Field over Field and Armature
3	400	$ 40.00	$ 30.00	$ 20.00	$ 10.00	$ 20.00	$ 10.00
5	400	65.00	50.00	35.00	15.00	30.00	20.00
10	400	128.00	85.00	65.00	33.00	63.00	30.00
15	400	185.00	140.00	95.00	45.00	90.00	55.00
25	400	300.00	225.00	150.00	75.00	150.00	75.00
30	400	355.00	263.00	175.00	90.00	178.00	88.00
35	400	405.00	305.00	205.00	100.00	205.00	100.00

These figures are based upon 1c per K.W. hour, hence upon a higher rate the savings will be in proportion to the increase in rate.

The interest (depreciation, taxes, etc.), on motor costs subtracted from the savings represent the net gain.

For Example:

*A 3 H.P. 400 R.P.M. motor:

50% reduction by armature control costs	$170.00
25% field, 25% armature costs	200.00
50% field control costs	230.00

The cost of combination:

Field and armature over armature	30.00
Field over combination	30.00
Field over armature	60.00

The yearly savings in power at 1c rate:

Field and armature over armature	$10.00
Field over combination	10.00
Field over armature	20.00

With interest, depreciation and taxes at 12% on the additional motor costs:

Motor Costs:

Armature and field over armature	$3.60
Field over combination	3.60
Field over armature	7.20

The net yearly savings are represented by the difference between the power saving and the interest charges, which in this case are:

Field and armature over armature	$ 6.40
Field over field and armature	6.40
Field over armature	12.80

These figures show no appreciable savings in favor of field control based upon this rate, but if a small user of power used this motor at a rate of say 5c per K.W. hour, the field control method would show a saving of $64.00, or $4.00 more than the additional initial cost of the armature control method motor the first year and in addition show a saving of $64.00 net each succeeding year. This saving will pay for the motor in 3½ years.

It may be generally stated that for

* The figures for the cost of the motors are arbitrary and are given merely to illustrate the method of calculation.

variations in speed of more than 25% from normal and where the low speeds last for the longest periods of time, the field control method shows the best practical economy. For speeds ranging from nearly 75% to nearly 100% normal, the combination control method type (in this case 25% field control) shows the best practical economy. At or very near full load speed (within 98%) the armature control is the best. In the latter case if the speed is always normal no control system is needed and an ordinary constant speed motor is sufficient.

Heat Transmission Through Various Types of Window Sash

ALSO CAUSES AND PREVENTION OF INTERNAL CONDENSATION IN DOUBLE-GLAZED SASH.

By ARTHUR N. SHELDON.

(*Presented at the annual meeting of The American Society of Mechanical Engineers, New York, December 5-8, 1916.*)

In the industrial plant of to-day, where there is so much emphasis placed upon maximum daylight, exterior wall surfaces consist principally of windows, and the heat loss through them is a very important matter. Indeed there may be a question in certain plants whether the window area is not carried to excess—that is beyond a point where increased daylight warrants the increased heat loss. In the absence of authentic data on the relative heat loss through various types of sash, these experiments were conducted by Mr. W. S. Brown, under the writer's direction, to enable us to logically design and proportion the fenestration of industrial buildings.

DESCRIPTION OF APPARATUS.

The sash tested were of such a size as completely to fill an opening on the face of a test box 4 ft. 2¾ in. wide by 7 ft. 9½ in. high, the test box being 1 ft. 2 in. deep. The box was constructed of 2-in. tongued and grooved white pine, covered with 2-in. cork boards and made airtight. Wool felt 1 in. thick was placed between the edge of the test box and the sash to reduce air leakage to a minimum. The box rested on two gypsum blocks as shown in Fig. 1.

The test box being set up on end, an electric heater was placed in the bottom. The heater consisted of six sets of resistance wire strung horizontally, and arranged so that, beginning at the bottom, the first two coils might dissipate approximately 0.25 K.W. each of electrical energy, the next two 0.50 K.W. each, and the uppermost two 0.75 K.W. each. The switching arrangement was designed to give a total capacity of 3 K.W., obtainable in successive stages of ⅛ K.W. each. Fig. 2 shows the arrangement of the heater and the ¼-in. asbestos board plates, 15 in. high, which were fastened against the lower frame of a

FIG. 1—FRONT OF TEST BOX, SHOWING GYPSUM BLOCK SUPPORTS, BAFFLE BOARDS, HEATER AND SASH.

heater to prevent direct radiation of heat to the lower panes of glass.

Air temperatures within the box were recorded by twelve thermometers, arranged opposite the various panes of glass, and giving a fair average of the internal temperatures. The total average temperature was obtained by averaging the individual temperatures behind each horizontal row of panes. The Fahrenheit long-scale chemical thermometers used protruded about 7 in. through the back of the box and its covering, and were tested for accuracy before and after the experiments.

Air temperatures outside the box were observed by means of an accurate wall thermometer, registering maximum and minimum temperatures. A thermostatically-controlled steam radiator maintained a constant temperature outside. Two electric fans directed currents of air against the test box at an angle of 30 degrees and provided positive and constant circulation over it. While it was not possible or necessary to reproduce actual wind conditions, 11½ miles per hour for New England during the heating season, anemometer readings during the tests showed that the conditions obtained were not far from the average to be expected. Vertical baffles protected the back and sides of the box from the air currents.

Measurements of electrical energy converted into heat were obtained simultaneously by means of two meters, the first a standard indicating wattmeter,

FIG. 2—INTERIOR OF BOX WITH THERMOMETER.

accurate within 14 of 1%, and compensated for temperature changes, and the other a standard service watt-hour meter, installed and adjusted by the service company furnishing the power.

FIG. 3—GENERAL ARRANGEMENT OF FANS, SWITCHBOARD AND METERS.

The humidity of the air was kept as constant as possible throughout the series of tests by means of water-saturated felt, and was measured by a wet and dry-bulb hygrometer. The humidity remained constant during the period of each individual test.

METHOD OF CONDUCTING TESTS.

The average temperature of New England during the heating season being 36° F., it was decided to make tests at a room temperature corresponding to 76°, or a temperature difference of 40°. For greater accuracy, and to obtain the transmission rate in colder weather, there were tests made at 70° temperature difference as well.

To determine what amount of heat was transmitted through the sides and back of the test box, blank runs were made in which the opening in the face of the box was closed by materials of which the box itself was made. These tests were run very carefully over an extended period of time (at least 18 hrs.) to make sure that all conditions had become constant, after which hourly read-

ings were taken for eight hours. The temperature difference during the run did not vary more than 1° F. The fans were not in operation during the blank-run tests, as the object was to determine the rate of transmission through the box and covering under the conditions of the test; still air on top, sides, back and bottom. In order to reduce any slight error due to a possible change in conductivity of the box itself during the experiments, tests were run to obtain these constants at 40° and 70° heat head both before and after the series of sash tests. It was found that a slight increase occurred due evidently to shrinkage and warping of the boards.

FIG. 4—FRONT OF BOX COVERED FOR BLANK RUN.

Sash tests were conducted in the same manner, except that the fans were put in operation. In each separate test, the watt-hour meter was calibrated for the load by timing it for ten minutes with the instantaneous meter and counting the revolutions of the disk. During all tests, a careful record was kept of the panes of glass on which condensation occurred.

COMPUTATIONS OF TESTS ON HEAT TRANSMISSION.

The heat transmission through the sash has been worked out and expressed on the basis of B.T.U. transmitted per 24 hrs. per deg. F. per square foot of opening, and is designated in the formula following as H, whence

$$H = (L - l)/ad \qquad [1]$$

where

L = total heat loss through test box and sash in B.T.U. per 24 hrs. as computed from watt-meter measurements

l = heat loss in B.T.U. per 24 hrs. through top, bottom, back and sides of test box, as determined from blank run and corrected for actual temperature difference during test

a = area of opening filled by sash = 33 sq. ft.

d = temperature difference throughout test.

L is found from the formula

$$L = (w \times 3412 \times 24)/t$$

where w = electrical energy dissipated in heater as measured in kilowatts at average temperature d

t = duration of test, hours

3412 = the equivalent of 1 K.W. in B.T.U.

In the same manner l is found from the blank-run tests by the formula

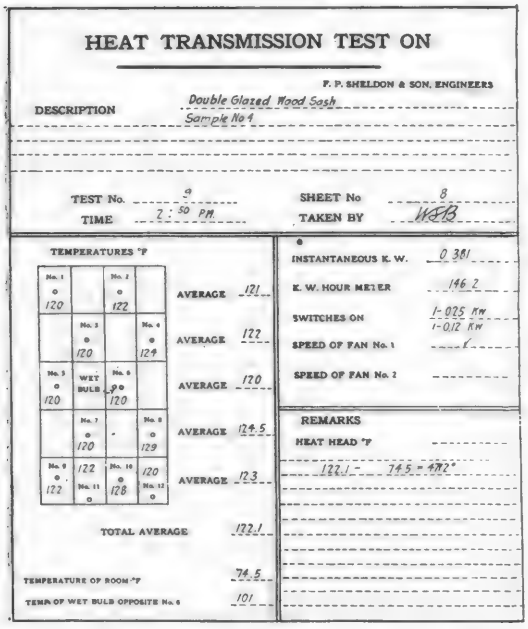
$$l = R\ (w \times 3412 \times 24)/t$$

where R = the ratio of the top, bottom, sides and back of the sash exposed during the sash tests, to the total area of the box, or that exposed during the blank run. As noted above, l should be taken at the same temperature as L by interpolation from the known results, if necessary. The other terms have the same meaning as above.

DESCRIPTION OF THE SASH TESTED.

Tests were conducted on the following seven samples of sash, all without ventilators. The word "pane" refers to a single sheet of glass, whereas "light" refers to a section of sash, or, in the case of double-glazed sash, two panes and the air space.

Sample No. 1 was standard single-glazed, solid, rolled-steel sash of 20 panes, each approximately 12 x 18 in., arranged 4 wide by 5 high. The panes



HEAT TRANSMISSION TEST ON

F. P. SHELDON & SON, ENGINEERS

DESCRIPTION: Double Glazed Wood Sash Sample No 1

TEST No. 9 SHEET No 8

TIME 2:30 PM TAKEN BY WSB

TEMPERATURES °F

No. 1 120		No. 2 122		AVERAGE 121
	No. 3 120		No. 4 129	AVERAGE 122
No. 5 120	WET BULB	No. 6 120		AVERAGE 120
	No. 7 120		No. 8 129	AVERAGE 124.5
No. 9 122	No. 11	No. 10 128	No. 12 120	AVERAGE 123

TOTAL AVERAGE 122.1

TEMPERATURE OF ROOM °F 74.5

TEMP OF WET BULB OPPOSITE No. 6 101

INSTANTANEOUS K. W. 0.381

K. W. HOUR METER 146.2

SWITCHES ON 1-025 KW 1-012 KW

SPEED OF FAN No. 1 1

SPEED OF FAN No. 2

REMARKS

HEAT HEAD °F

122.1 - 74.5 = 47.6°

FIG. 5—SAMPLE HOURLY RECORD SHEET.

were ¼-in. rough wire glass. The sash bar section was 1⅜-in. deep, the glass being bedded on the front side and puttied from the inside, the putty having a good half-inch body. The exposed glass area was 28 sq. ft., or 85% of the total.

Sample No. 2 was a double-glazed solid, rolled-steel sash of the same make, size and arrangement of lights as Sample No. 1. The outside panes were ¼-in. rough wire glass, the inside panes being single-thick plain glass, separated from the former by a galvanized iron channel separator, making a ¾-in. air space. The sash bar was 2⅜ in. deep, the outer pane being well bedded on the outside with a 11/16-in. body of putty. The glazing was done from the inside.

Sample No. 3 was a double-glazed, solid, rolled-steel sash of same size and arrangement of lights as Sample No. 1. The outer panes were ⅛-in. factory ribbed glass (ribs inside) and the inside panes were single-thick plain glass separated from the former by a galvanized-iron channel separator, making a 3/16-in. air space. The sash bar was 1⅜ in. deep, the outer pane being bedded on the outside and the inner pane put on with a good half-inch body of putty. The glazing was done from the inside.

Sample No. 4 was an ordinary double-glazed wood sash, of same size and arrangement of lights as Sample No. 1. The outside panes were ¼-in. rough wire glass, the inside being double-thick plain glass separated from the former by a ⅝-in. air space. The sash was made of 1¾-in. stock, muntin bars being 5/16 in. The outer panes had a 5/16-in. body of putty and the inner panes ½-in. body, bedded. Glazing was done from both sides.

Sample No. 5 was a single-glazed wood sash of the same size and arrangement of lights as Sample No. 1, and was obtained from No. 4 by taking out the inside panes of plain glass.

Sample No. 6 was a double-glazed hollow metal sash. The lights were made larger than those of Sample No. 1, being 14½ in. by 21 in. and arranged three wide and four high. The outside panes were ¼-in. rough wire glass, the inside being single thick, plain glass, separated from the former by a ¾-in. air space. The exposed glass area was 23.5 sq. ft. or 71.5% of the total. The sash bar was 2⅛ in. deep. Muntin bars were 1¾ in. in external width. The outer panes were bedded to the outside and the inner panes were bedded to both sides.

Sample No. 7 was a single-glazed, hollow metal sash, of the same arrangement of lights as Sample No. 6, being obtained from it by removing the inside panes of plain glass, together with the galvanized-iron-formed sections which held them in place. This left the muntin bars 1½ in. deep.

RESULTS OF TESTS.

A résumé of the comparative heat-transmission rates, H, of formula 1, as deduced from the tests, is given in Tables 1 and 2.

The results of the tests have been plotted in the form of curves (Fig. 3). It will be noted that the rate of transmission increases with the temperature difference, and that there is a greater increase for the single than for the double-glazed sash.

To ascertain the cause of the much greater heat-transmission rate through solid steel compared with wood and hollow metal sash, a thermometer was inserted in a chamber in a 2-in. cork board, which, in turn, was placed against the

TABLE 1—HEAT TRANSMISSION RATES AT APPROX. 40° F. TEMPERATURE DIFFERENCE.

Sample	Actual Heat Head, Deg. Fahr.	*H* Computed at Actual Heat Head	*H* Corrected to 40 Deg. Fahr. Heat Head	Relative Humidity	Condensation
No. 1 Single-glazed solid steel	44.5	29.3	28.5	36	None
No. 2 Double-glazed solid steel, ¾-in. air space	37.4	20.4	20.5	34	None
No. 3 Double-glazed solid steel, ⅝-in. air space	45.7	22.8	22.5	43	Very slight on air-space side of one outside pane and box side of one inside pane
No. 4 Double-glazed wood, ⅝-in. air space	47.3	14.2	13.9	49	None
No. 5 Single-glazed wood	41.2	25.6	25.5	44	Hardly noticeable
No. 6 Double-glazed hollow metal, ¾-in. air space	43.9	15.4	15.2	54	On air-space side of one of outside pane
No. 7 Single-glazed hollow metal	46.0	27.1	26.4	43	All

TABLE 2—HEAT TRANSMISSION RATES AT APPROX. 70° F. TEMPERATURE DIFFERENCE.

Sample	Actual Heat Head, Deg. Fahr.	*H* Computed at Actual Heat Head	*H* Corrected to 70 Deg. Fahr. Heat Head	Relative Humidity	Condensation
No. 1. Single-glazed solid steel	73 9	34.2	33 6	28	All
No. 2 Double-glazed solid steel, ¾-in. air space	76 8	21 8	21.6	29	15 outer panes out of 20 showed moisture on air-space side
No. 3 Double-glazed solid steel, ⅝-in. air space.	76.0	24.2	24.0	30	One outer pane showed moisture on air-space side; one inner pane showed moisture on box side. Three lights showed both above
No. 4[1] Double-glazed wood, ⅝-in. air space	79.8	15.5	15.1	31	None
No. 5 Single-glazed wood	67.6	28.9	29.3	29	12 lights
No. 6 Double-glazed hollow metal, ¾-in. air space.	75.6	16.6	16.4	36	On air-space side of one outside pane
No. 7 Single-glazed hollow metal	77.7	30.5	29.7	25	All

[1] A test upon this same wood sash with the inside single-thick plain glass substituted for the double-thick showed an increase in *H* of 3 per cent at 70 deg. fahr. temperature difference.

bars of the sash. These tests showed that for a given temperature difference the steel bars were hotter than the wooden, and by their greater conductivity constituted a direct path for the transmission of heat to the outside. The hollow steel sash bars were warmer than the wood, but cooler than the solid steel. The steel bars also serve to increase the temperature of the air in the same space between panes in the double-glazed sash, and hence increase the transmission rate through the panes.

TYPICAL PROBLEM IN RELATIVE COSTS.

In order to emphasize the practical application of these experiments, a typical problem is given. In the design of reinforced-concrete buildings there arose the question whether to use single or double-glazed steel sash. The following data apply to the problem:

Wall openings to be glazed .....37,800 sq. ft.
Average inside temperature, heating season ...70° F.
Average outside temperature, heating season ...35° F.
Average temperature difference, 70 — 35° F. ..35° F.
Heat delivered from steam plant per pound of coal.8500 B.T.U.
Length of heating season .....4850 hours
Cost of coal per 2000 lbs..$4.00
Assumed cost of hot-water heating plant per square foot of heating surface, including heater, based on — 10° F. outside temperature $0.60

Proposition A, single-glazed steel sash. From the tests, *H* at 35° F. = 27.7 B.T.U per degree difference in temperature per square foot per 24 hours.

Comparative yearly coal bill[1].$ 1,750.00
Comparative initial investment cost of sash erected 15,600.00
Cost of heating system to supply window loss only, based on 18,400 sq. ft. at $0.60 .. 11,404.00

Total investment ...$26,640.00

[1] $$\frac{\$4.00 \times 37{,}800 \text{ sq. ft.} \times 27.7 \text{ B.T.U.} \times 4850 \text{ hrs.} \times 35^\circ \text{F.}}{2000 \text{ lbs.} \times 24 \text{ hrs.} \times 8500 \text{ B.T.U.}} = \$1{,}750.00$$

Proposition B, double-glazed steel sash, 3/16-in. air space. From the tests, H at 35° F. = 22.3 B.T.U. per degree difference in temperature per square foot per 24 hours.

Comparative yearly coal bill	$ 1,410.00
Comparative initial investment cost of sash erected	21,000.00
Cost of heating system to supply window loss only, based on 12,800 sq. ft. at $0.60	7,680.00
Total investment	$28,680.00

Proposition C, double-glazed steel sash, ¾-in. air space. From the tests, H at 35° F. = 20 B.T.U. per degree difference in temperature per square foot per 24 hours.

Comparative yearly coal bill	$ 1,260.00
Comparative initial investment of sash erected	25,750.00
Cost of heating system to supply window loss only, based on 11,500 sq. ft. @ $0.60	6,900.00
Total investment	$32,650.00

From Table 3 it is evident that an investment of $2,040.00 for B over that for A would result in an annual saving of $340.00 worth of coal, or 17% gross on the additional investment. Also, an additional investment of $6,010.00 for C over that for A would result in an annual saving of $490.00 worth of coal, or only 8% gross on the additional investment. The choice, therefore, lies between A and B; and whether or not B should be preferred will depend largely upon what the owners expect to make upon their other investments. It should be emphasized here that with a different unit cost of coal, a warmer or a cooler climate, or a different heating system, the conclusions might be changed entirely.

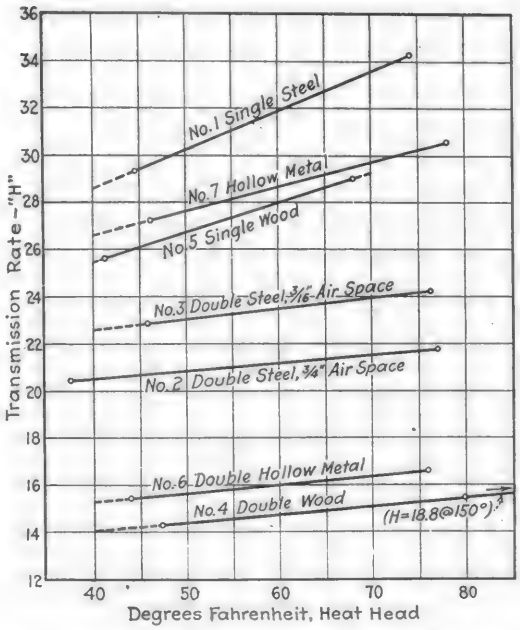


FIG. 6—DIAGRAM OF VARIOUS TRANSMISSION RATES, H, FROM TESTS.

INTERNAL CONDENSATION IN DOUBLE-GLAZED SASH.

Where condensation occurred in the air space, it was always on the outside pane of glass, which, of course, was the cooler one. The wood sash showed none, but it was very marked in the solid steel, and noticeable in the hollow metal sash. To determine, if possible, the cause for this condensation, holes were bored in some of the lights of the solid steel sash which had shown condensation, and in some which had not. Each light was then tested by blowing smoke into the hole, and some were found to leak considerably, some to adjacent spaces, others to front or back, and a few showed combination of those conditions. It was observed that where condensation was evident, the greatest leakage was to the inside of the box, and that where there was no condensation, the greatest leakage was to the air outside the box.

TABLE 3—SUMMARY OF RESULTS.

	Yearly Coal Bill	Initial Expenditures		
		Sash	Heating System	Total
Proposition A	$1,750.00	$15,600.00	$11,040.00	$26,640.00
Proposition B	1,410.00	21,000.00	7,680.00	28,680.00
Proposition C	1,260.00	25,750.00	6,900.00	32,650.00

Following this clue, the entire sash was reglazed, and holes bored in seven of the outer panes, and in five of the inner panes. Free communication was thus established either to the external cool air or to the warmer air inside the test box. Each pane of glass opposite those with holes was carefully bedded to confine and control the air leakage to the side having the hole. Smoke tests before and after each run showed that the desired object had been attained by this means. The remaining eight lights were made as air tight as possible on both sides by careful bedding and setting. The sash was then placed on the front of the box as in the previous tests, the temperature raised to about 70° F. above that of the surrounding room, and records were kept as before of temperatures, relative humidity, and condensation, this being allowed to accumulate for a period of at least eighteen hours. The relative humidity in the test box was maintained at 40%, and that of the air outside varied from 60 to 90%, apparently having little effect upon the results.

A careful examination of the sash showed uniformly the following results:

a. Lights in which the air space opened to the outside or cooler air only showed no condensation.

b. Lights in which the air space opened to the warm air inside the box showed much condensation.

The sash was then reversed with its outer side toward the interior of the test box and, after a test of three days, examination showed that the air spaces in which there had been condensation during the previous tests were now dry, while abundant condensation appeared in those which showed none in the first test. It was also discovered that by varying alternately the temperature in the test box, the processes of condensation and drying could be accelerated. The experiment on the reversed sash, therefore, confirmed conclusions *a* and *b* above.

The explanation is simple. Changes of temperature on either side of the sash cause corresponding, though less marked, changes in the temperature of the air space. The pressure of the confined air, therefore, becomes more or less than atmospheric and air is correspondingly either forced out or admitted through the drilled holes, and, if the temperature difference is alternately increased and decreased, a breathing action obtains in the air space. A similar action occurs through leaks in actual practice and is due to variations in temperature.

Air entering an opening of this kind from the inside, coming as it does from the warm interior of the test box or building, becomes chilled, condensation necessarily appearing if the cooling is carried below the dew point. Breathing, or a repetition of this process, necessarily results in a gradual accumulation of condensation.

Conversely, air entering an opening of this kind from the outside becomes heated and its relative humidity is correspondingly decreased, making impossible the precipitation of any moisture.

CONCLUSIONS.

Condensation in the air space of double-glazed sash can be eliminated almost entirely by connecting the air space directly to the outside air, and at the same time effectively sealing it from the entrance of warm air within the building. In attempting the design of double-glazed sash according to these principles, it is suggested that the following points be considered:

a. The opening should be very small, say a hole ⅛-in. hole, to prevent a direct loss of heat by convection from the air space.

b. The location of the breathing hole is immaterial, except that a consideration of heat economy makes the bottom preferable.

c. The breathing hole should be protected from the weather and dirt.

d. A high-grade, elastic putty should be used. On account of wind pressure, difference of expansion between steel and glass (about 65%), careless setting, etc., absolute sealing of the inner panes probably will not be accomplished. However, these tests, show that a sufficient degree of tightness can be obtained, and that the larger part of the breathing will occur through the opening made for this purpose.

e. Leaks between air spaces should be eliminated.

Fuel Economies in House Heating.

By H. R. JOHNSON

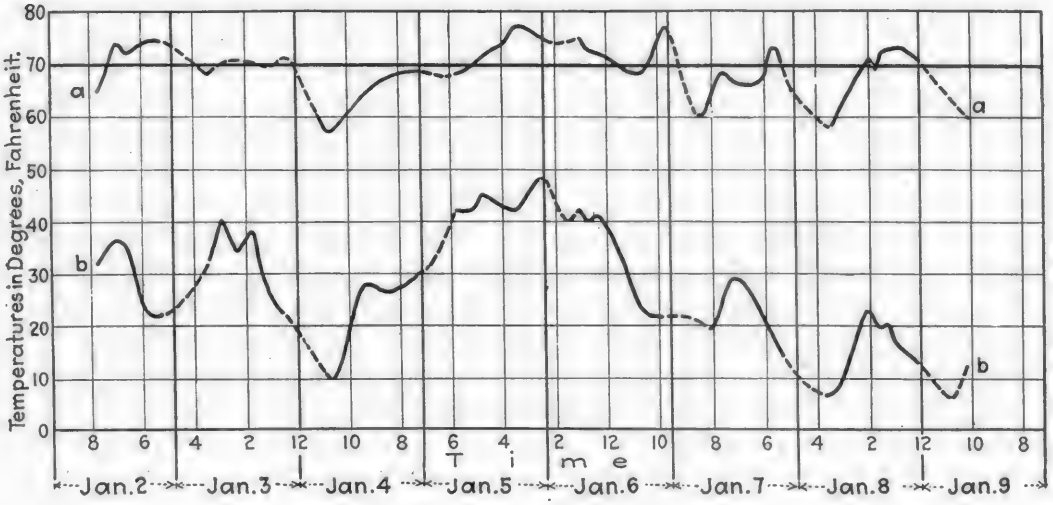
Throughout the northern states, the available kinds and grades of fuel for house heating, and their *relative* as well as *actual* costs, vary widely in different sections. Moreover, the results obtainable with a given fuel are dependent to quite an extent upon the type of heater employed. Hence the results of one set of tests are to be applied with caution to any other set of conditions; and for close results, it is practically necessary for anyone to try the thing out for oneself.

The following description of the methods used by the writer in settling this problem may be of interest. The apparatus required consisted only of two thermometers, an ordinary coal scuttle and a spring balance. The extra time required would hardly exceed fifteen minutes per day, so that there is no reason why similar tests should not be carried out by anyone desiring to do so. The immediate as well as incidental knowledge gained will almost certainly pay for the slight amount of trouble involved. For example, we found out that, by using "pea" size anthracite instead of "egg," we could save over one-quarter of our costs; and, by using bituminous coal, we could save slightly over one-third. We also found that of three one-ton lots of coal, that were completely weighed, one fell short of the supposed weight by 85 lbs.; the second, 210 lbs., and the last 64 lbs. Close attention to the problem for a considerable length of time added much to our knowledge of proper furnace management.

GENERAL SCHEME OF TESTS.

The general scheme of our tests took into account the fact that the number of heat units required per hour to maintain comfortable room temperature depends directly upon the difference between the inside and outside temperatures, and also, but less definitely, upon the average wind velocities. The inside and outside temperatures were therefore recorded at sufficiently short intervals so that a close determination of the average daily difference could be made. Our outdoor thermometer, being of the maximum and minimum, self-recording type, gave us the lowest point reached during the night. It was found, however, that during normal weather, the lowest temperature was reached at about 6 or 7 a. m. and could be read after rising.

Since temperature readings were



TYPICAL CURVES SHOWING TEMPERATURE VARIATIONS.
a living room. *b* outside.

TABLE 1

Date	Time	Temperatures, Deg. F. (a)	(b)	(a—b)
Jan. 2	9 a. m.	63.7	31.5	*16.1
	1 p. m.	70.4	33.5	40.5
	5 p. m.	73.7	28.0	45.7
	9 p. m.	74.5	22.0	52.5
Jan. 3.	1 a. m.	71.7	24.5	47.2
	5 a. m.	68.0	29.5	38.5
	9 a. m.	70.0	39.5	30.5
	1 p. m.	70.0	35.2	34.8
	5 p. m.	69.8	31.5	38.3
	9 p. m.	71.0	22.2	48.8
Jan. 4	1 a. m.	67.5	16.5	51.0
	5 a. m.	58.5	10.5	48.0
	9 a. m.	60.0	16.0	44.0
	1 p. m.	64.5	28.0	36.5
	5 p. m.	67.0	26.0	41.0
	9 p. m.	68.1	27.5	40.6
Jan. 5	1 a. m.	68.5	32.0	36.5
	5 a. m.	68.3	38.5	29.8
	9 a. m.	68.8	42.0	26.8
	1 p. m.	72.0	44.0	28.0
	5 p. m.	75.2	42.0	33.2
	9 p. m.	74.0	46.0	28.0
Jan. 6	1 a. m.	75.5	49.5	26.0
	5 a. m.	74.0	40.0	34.0
	9 a. m.	72.0	40.5	31.5
	1 p. m.	70.0	36.0	34.0
	5 p. m.	68.0	27.0	41.0
	9 p. m.	73.0	21.1	51.9
Jan. 7	1 a. m.	71.1	21.2	49.9
	5 a. m.	62.5	19.7	42.8
	9 a. m.	67.7	25.0	42.7
	1 p. m.	66.1	28.5	37.6
	5 p. m.	66.7	22.8	43.9
	9 a. m.	69.4	14.7	54.7
Jan. 8	1 a. m.	62.6	10.0	52.6
	5 a. m.	58.8	7.4	51.4
	9 a. m.	63.0	10.0	53.0
	1 p. m.	69.7	22.0	45.7
	5 p. m.	72.2	19.7	52.5
	9 a. m.	72.8	15.0	57.8
Jan. 9	1 a. m.	68.8	11.2	57.6
	5 a. m.	64.0	7.0	57.0
	9 a. m.	59.5	12.5	*23.5

Sum of (a-b) readings = 1777.4

Average (a-b) = sum ÷ 42 (readings) = 42.32

$*\frac{a\text{-}b}{2}$ for first and last readings in order to figure correct average.

necessarily taken at more or less irregular intervals, it was necessary to plot the readings in the form of curves, from which, in turn, close approximate values could be taken for any hour desired. Fig. 1 is a typical set of curves covering a seven-day test. The dotted portions of the curve, representing temperature variations, during the night, are assumed from the trend of actual readings.

At the end of the tests, usually lasting for four to seven days, the *average* difference between the inside temperature (a) and the outside temperature (b) was determined as indicated in Table I, the values shown being taken from the curve for equal intervals of four hours.

In the meantime a careful record was kept of the number of pounds of fuel burned, care being also taken to have the depth and condition of the fire as near the same as possible at the beginning and end of the test. (Tests should begin and end at the same time of day.)

The consumption of various fuels was reduced to a basis of pounds of coal per degree temperature difference (a-b) for one day. For the test just cited, the fuel was anthracite pea, of which 649 lbs. were burned in seven days. Our factor for comparison for pea coal is therefore

$$\frac{649}{7 \times 42.32} = 2.19 \text{ lbs.}$$

Table II gives a comparative summary of results obtained with two other fuels.

The "Comparative Cost Factor" which appears at the end of the table takes into account the differences in price of the samples of coal under test, and gives the final comparison of the cost of doing an equivalent amount of heating with each kind. This factor is found by multiplying the "consumption factor" by the cost per pound of the fuel under test.

COMPARISON OF RESULTS.

In comparing the results of such tests a certain amount of judgment is required unless the conditions of weather and outside temperature are very nearly the same during each test period. During

TABLE II

	Test No. 1	2	3
Kind and Size of Fuel	Lackawanna Egg	Anthracite Pea	Cumberland Bituminous
Amount of Fuel, Pounds	423	649	552
Amount of Refuse, Pounds	54	97	53
Refuse, percentage of Fuel	12.7	15.0	9.5
Average temperature difference (a-b), Deg. F.	40.26	42.32	45.04
Average wind conditions	Moderate	Moderate	Fresh
Duration of Test, Hours	108	168	120
Comparative Consumption Factor, Lbs.	2.32	2.19	2.45
Price per Ton	$8.00	$6.00	$5.00
Comparative Cost Factor, Cents	0.928	0.657	0.613

windy weather somewhat more fuel will be required, which will reflect unfavorably on the fuel under test. Differences in outside temperature may affect the cost factor either way, since the efficiency of the furnace increases with the demand put upon it up to a certain point and, beyond that point, falls again quite rapidly. Before starting a record test, a new fuel should be used until a certain familiarity has been gained with the changes in method of management which may be required to get good or comparable results.

It will be noted that in the tests just cited a very fair comparison seems to have been made possible, except that in the case of No. 3 the stronger wind prevailing had a slightly unfavorable effect.

MANAGEMENT OF THE HEATER.

This is another opportunity for immediate economies. This does not refer to the endurance of discomfort in order to use less heat, but to the possibilities of operating the heater so as to get the needed heat with less fuel consumption. A lengthy article might well be written with reference to this subject. We shall, however, refer only briefly to a number of the most important points, as follows:

(*a*) Run as steady a fire as possible; *i.e.*, try to maintain the desired temperature by running a fire to suit the requirements, rather than by alternately forcing and checking.

(*b*) Anticipate changes in temperature as much as possible and *gradually* force or retard the fire to meet the expected demand, thus avoiding sudden checking or forcing, or disturbance of the fuel bed by excessive shaking or poking.

(*c*) Attend the heater often enough to prevent dead spots or holes from forming in the fuel bed.

(*d*) Excessive shaking causes loss of fuel through the grate. Except in severe weather the ashes should be shaken down not oftener than two or three times daily, and then only until a glow is to be seen in the ash-pit.

(*e*) Keep the fire pot well filled and rounded up. Decreasing the thickness of the fire is only to be recommended when necessitated by the use of small grades of coal or by weak draft.

(*f*) When burning other fuels than anthracite coal, the so-called coking method of firing is to be recommended, the object being to more completely burn the volatile products which are given off by fresh fuel. Before adding fuel push the top of the fire to one side, forming a bank that will not be covered after the firepot is fully filled. This bank of incandescent coals will readily ignite the gases given off by the green fuel.

(*g*) Regulate the fire by operation of both ash pit and check drafts. Under average conditions about the best results will be obtained, with a minimum of manipulation, by connecting the two through a system of chains and pulleys so that one opens automatically as the other is closed. Closer attention is likely to be given the drafts during the day time, by connecting the drafts by chains to a suitable wall attachment in the living room, hall or similar convenient place. The *best* results will be obtained by the use of a good type of automatic draft regulator, several of which are on the market.

(*h*) Never check the fire by leaving the feed door open. (Some fuels re-

quire the admission of a slight amount of air above the fire, the small damper in the fire door is, however, ample for the purpose, and is not needed when using anthracite coal.)

(*i*) Keep heating surfaces, or flues, swept clean so that they will readily absorb heat.

Heating and Ventilating System for San Francisco's City Hall.

The wide publicity given to the new city hall, in San Francisco, which has risen from the ashes of what was only a few years ago a fire and earthquake-ridden city, lends special interest to the elaborate heating and ventilating plant, which was installed in this building according to the design of Leland & Haley, consulting mechanical engineers, of San Francisco. The following description of the system was contributed by William E. Leland, S.B., to The Architect and Engineer, of San Francisco:

The heating and ventilating apparatus has been designed as a combination system, with direct radiation supplying all the heat required for the entire building, with an additional mechanical system of ventilation for the entire first floor and basement and for all court rooms.

The heating is accomplished by direct radiators located in each room and supplied with steam from the municipal power plant for the Civic Center. The piping system is arranged for the circulation of steam by the mechanical vacuum system, with vacuum pumps located in one of the fan rooms in the basement. The piping is arranged on the overhead system, with down feed risers and return mains in the basement.

All of the direct radiators in the principal rooms are automatically controlled by thermostats, so the room temperature is maintained at a constant point without attention.

The ventilating apparatus for the first and basement floors consists of two fresh air supply fans, each designed to deliver 43,000 cu. ft. of air per minute, together with two exhaust fans of about the same capacity, each pair of fans serving half of the space in these two floors.

The fresh air is brought down from the roof through two large air shafts at the side of the central dome and passes through air washers and heating stacks in the fan rooms in the basement, where it is thoroughly cleaned and moistened and heated to a temperature of about 75°. This temperature is automatically regulated by a thermostat in the main duct. From the fans the air is distributed to the various rooms through galvanized iron ducts on the basement ceiling.

The exhaust air is similarly collected from the rooms and is drawn out by the two exhaust fans and discharged to the roof through two large exhaust shafts similar to the fresh air fans.

The court rooms on the two upper floors and the Supervisors' chamber and a few important rooms on the second floor are similarly ventilated by four fresh air supply fans located in the attic. Each of these fans supplies one-quarter of the building and is designed to handle an average of 20,000 cu. ft. of air per minute.

The air is drawn in from the roof as in the case of the basement fans and is passed over air washers and heating stacks and heated to a temperature of approximately 75° and is discharged to the rooms through a system of ducts and flues.

For all of these rooms in the upper stories vent flues have been provided running to the attic space, which in turn is vented to the outside air by screens set all around the inner court walls.

The toilets are arranged in tiers in each corner of the building and each tier is provided with an exhaust fan with flues connected to each toilet. This exhaust ventilation is also extended to all the smaller toilets throughout the building that have no direct outside ventilation.

The four toilet exhaust fans are designed to handle from 4,500 to 8,500 cu. ft. of air per minute each, depending on the number of toilets on the system.

A small individual exhaust fan has been provided for the chemical laboratory in the basement and a similar small exhaust fan for the blueprint department in the attic.

The apparatus as a whole provides for the supply of approximately 19,800 sq. ft. of direct steam radiation, 5,376 sq. ft. of indirect Vento radiation in connection with the fresh air supply, a total fresh air supply of 166,000 cu. ft. per minute, a total mechanical exhaust of 112,000 cu. ft. per minute and approximately 830 gal. of circulating water per minute for the air washers.

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IT IS surprising how many public projects nowadays depend for their success on mechanical ventilation. The latest to be included in this category is the proposed new vehicular tunnel under the Hudson River, connecting New Jersey and New York. This, to be sure, is a revival of an old scheme, but unlike the conditions that had to be met in former days, the principal reasons for and, strangely enough, the principal objection to, the construction of the tunnel is the automobile. In seeking an easy and rapid route from the Jersey suburbs to the metropolis, the tunnel plan has many advantages, but it appears to have been entirely overlooked that the exhaust gases from automobiles would prove an almost insurmountable obstacle to its feasibility.

It will be recalled that when the first plans were made for the New York Subway, it was before the advent of the electric motor and the original scheme always included trains drawn by coal-burning steam locomotives. Fortunately for all concerned, the first project was not carried out for other reasons, but it is easy to see now that the presence of the locomotives was sufficient in itself to foredoom the plan to failure.

In the case of the projected New York-New Jersey vehicular tunnel, it is estimated that its length, with the necessary approaches, would be not less than 1½ miles and that it could be ventilated only from the ends. According to expert opinion, it would be impossible to run safely even a moderate number of automobiles through such a tunnel, as the amount of carbonic oxide, to say nothing of unburned gas, would be too great to be handled in any practicable manner by ventilating fans.

The same expert refers to the use of gasoline locomotives in coal mines, but here, he states, a powerful forced ventilation exists and the amount of gasoline burned is a mere trifle compared with the amount that would be required to move the automobile traffic that now crosses the North River. Yet the fumes from gasoline locomatives in coal mines have proved so objectionable that their use, in some cases, has been abandoned.

All of which is another evidence of the important place mechanical ventilation is assuming in modern life.

FOLLOWING previous special issues of THE HEATING AND VENTILATING MAGAZINE on air conditioning (July) and smokeless boilers (October), we take pleasure in announcing the January issue as an "Industrial Number." In that issue will be shown some of the advances that have been made in the adoption of better heating methods in industrial plants generally, as well as some of the more important industrial processes in which properly-designed heating and ventilating apparatus has become a prime necessity.

The Consulting Engineer

"The Consulting Engineer" is prepared to reply in this department, to any questions which our readers may ask regarding problems connected with the design and installation of mechanical equipments of buildings.

68—A Problem in Handling Condensation.

QUESTION: A high school is to have an annex building 135 ft. away from the main school. It is to be heated with steam taken from the main boiler in the high school. The minimum outside temperature is to be about 40° F. below zero, and heat will be required in the building about eight months out of the year. It is estimated that 720 sq. ft. of direct steam radiation will be required to heat the building to 70°.

The annex is so situated that it is not possible to get a gravity return back to the boiler. Our problem then is whether it will be profitable to waste this condensation, or whether the saving in using a condensation pump and returning the water to the boiler would be worth while. This is a problem that is very common to this locality, and we would appreciate it if you would give us your figures as to which would be the most economical to use.

ANSWER: Our correspondent does not state the price of fuel, price of public service current or the price of water in the section referred to, also the contemplated steam pressure is not given or whether automatic heat control is used in the school. We will, however, make the assumptions necessary to demonstrate the method and the results can be modified to suit individual conditions.

There are several methods of overcoming this trouble:

1. By means of a hydraulic pump placed in the annex, wasting the cold water to sewer, always provided there is sufficient street pressure.

2. By electric motor-driven pump and receiver, with automatic starting and stopping devices.

3. By raising the boiler pressure, placing a reducing valve on the steam line and operating two return traps in the annex building, as well as one for the main building.

The first requirement will be to find the cost of water and heat lost by wasting the condensation. We will assume the system operated at all times when the temperature is below freezing and only during school sessions when the temperature outside is above 32° F., or freezing. The hours of operation will be approximately as follows:

Outside Temperature, Deg. F. below zero.	Sessions 30 hours.	Non-sessions, 67 hours.
0 to 10	50	257
10 to 20	110	750
20 to 30	270	1168
30 to 40	200	950
40 to 50	232	...
50 to 60	182	...
Total	1074	3192

We will assume 50% capacity of the apparatus in condensation above 30° outside, and 100% capacity below 30° outside. Then there are at 100% capacity: non-session, 2242 hrs.; session, 460 hrs., or a total of 2702 hrs. With a capacity above 30° F. of 50%, there are 950 non-session hours and 614 session hours, or a total of 1564 hours. 1564 hrs. at 50% capacity = 0.15 lbs. condensation per square foot of heating surface. 2702 hrs. at 100% capacity = 0.3 lbs. condensation per square foot.

The total condensation for the season will be:

720 sq. ft. x 0.3 lbs. x 2702 hrs. = 583,632 lbs. water.

720 sq. ft. x 0.15 lbs x 1564 hrs = 168,912 lbs. water.

Total 752,544 lbs. water.

752,544 ÷ 62.5 = 12,041 cu. ft. per season and at $1.00 per 1000 cu. ft. this will be $12.04 as the cost of the water wasted.

The heat lost in fuel by wasting condensation and heating new feed water, assuming the cold water at 50° F. and that the condensation leaves the heating system at 200° F., will be 150 B.T.U. per pound. 150 x 216 = 32,400 B.T.U. per hour, or approximately 1 boiler horsepower increased load on the boiler, or in ordinary square feet of direct radiation, at 259 B.T.U. per square foot: 32,400 ÷ 250 = 130 sq. ft. of radiation additional capacity. The actual fuel wasted would be represented as follows, if we allow an efficiency of 50% as the portion of heat of coal delivered in steam by the boiler (figuring coal at 12,000 B.T.U. per pound, anthracite).

$$\frac{150 \times 752{,}544}{0.5} = 225{,}763{,}200 \text{ B.T.U. per season.}$$

$$\frac{225{,}763{,}200}{12{,}000 \times 2{,}000} = 9.4 \text{ tons of coal}$$

per year. If coal is $6.00 per ton the cost will be:

Coal	$56.40
Water	12.04
Total	$68.44

If a hydraulic pump were used, with a water pressure of about 35 or 40 lbs., it would probably use twice as much as would be pumped back to the boiler or, if $12.04 worth of water was to be pumped, the cost of operating the pump would be $25.00 per year, plus interest, depreciation and upkeep of pump.

If electric current were purchased at 5c. per kilowatt hour, and the pump were automatically regulated, the current consumed would be, if 752,544 lbs. of water were raised against, say, 40 ft. head, which would be the maximum pressure of the boiler, plus friction of water in the pipes:

$$\frac{752{,}544 \times 40 \text{ ft.}}{33{,}000 \text{ (ft. lbs.)}} = 912.12 \text{ horsepower hours}$$

and multiplying this by ¾ will give the kilowatt hours, or 684.12 kw. hrs.

If the pump were 50% efficient, the kilowatt hours would be 1368.24 which at 5c = $68.41 as the cost of the current, or just about what it would cost to waste the condensation.

The trap system would cost about $500.00 to install properly as it would require two return traps and connections, but the operating expense would be practically nothing. It would, however, require a fairly good mechanic to install it properly. About the only precaution is to have a separate steam line direct from the boiler to operate the traps, because if the connection is taken off the heating line, even back of the reducing valve, the traps are apt to hang up at times.

69—Waste Pipes for Corrosive Acids.

QUESTION: In a certain schoolhouse installation where there is a chemical laboratory for students' use, standard lead wastes and cast-iron pipe have been used for draining the chemical wastes. No thought has been given by the architect to the fact that chemicals have a very corrosive action on these materials. Is there any practical way of floating in a coating on the piping from the sink drains so as to protect the pipes against corrosion, or do you think it is necessary to coat them? If not, can you cite experiences of others who have been confronted with this situation? Do you know of any cases on record as to how soon deterioration has rendered the wastes defective?

ANSWER: Lead wastes would probably last fairly well, as dilute acids have slight action on lead. Iron, however, is rapidly attacked by dilute acids while being practically immune from concentrated acids. Lead is used largely for the manufacture of sulphuric acid.

Black tin pipes have been used for this purpose, but any metal of this class is exceedingly expensive and inasmuch as different kinds of chemicals are apt to be used it would be rather hard to name one material that some of the chemicals would not attack. In view of all the conditions it would probably be best to leave the lead pipes as they are and renew them when worn out. This is the policy usually followed in boiler feed piping. Such piping was formerly made of heavy brass, but now most power plants use extra heavy iron and replace the pipes when necessary.

The writer does not know of any coating that could be used that would stand as well as the metal. Monel metal has been used for fans where gases containing corrosive chemicals are handled, but the writer has never heard of its being used for wastes.

LEGAL DECISIONS

"Doing Business" in State.

The Michigan Supreme Court holds that a contract by a foreign corporation, which has not complied with the corporation laws, for the sale of superheaters requiring that the corporation not only manufacture and ship, but also erect them in the buyer's plant in the state is invalid as a contract for doing business in the state, unless the foreign corporation suing on the contract can prove that the installation was, because of some peculiar quality of the apparatus, essential to the making of the sale.—Power Specialty Co. vs. Michigan Power Co., 157 N. W. 408.

Rates for Domestic Heating Appliances.

An electric lighting and power company was ordered by the Oregon Railroad Commission to amend its rates so as to permit domestic heating appliances and small motors not exceeding 2 k.w. total connected load to be used as a part of the installation under its regular business or schedule rates, it appearing that the company's schedules for power rates had formerly been applied

to current consumed by such small motors and heating appliances, which schedules were based on the maximum demand of the consumer with a minimum charge of $1.00 per kilwatt of maximum demand, but which provided that no maximum charge of less than $2.00 would be considered.—Hubbard Creamery Co. vs. Molalla Electric Co.

Reasonable Rates for Heating Service.

The Idaho Commission holds that the fact that a flat rate for electricity for water heaters amounts only to about one-fourth of the cost of the service, if the consumers use their heaters twenty-four hours a day on high, is not sufficient to overcome the presumption of reasonabless attaching to a voluntarily established rate, particularly where the heating service is furnished in connection with electric service for cooking. Such service is very profitable, and it appears that some of the patrons use their heaters part of the day on high, part of the day on medium, part of the day on low, and part of the time shut off altogether, and the company although it has something like 2,300 lighting consumers, had secured, after much advertising and soliciting, only about 30 water heating consumers and where it further appeared that the company has abundance of surplus power even when the peak load is on. The Commission was also of the opinion that it did not have jurisdiction of the complaint against the rates, since it was made by a competing utility, and not by one of the parties designated in the public utilities act, but it preferred to decide the case upon the merits rather than on a jurisdictional question.—Pocatello Gas & Power Co. vs. Southern Idaho Water Power Co.

Application of Money Derived from Contract.

The constructors of a heating plant in a school building applied money received from the contractor with instructions as to its application to unsecured debt, in good faith, and without knowledge of the source of the money, which was derived from a contract for the performance of which the contractor had furnished surety. In an action on the bond it was held that the contractors of the heating plant were entitled to have their appropriation remain undisturbed and to hold the surety for any deficiency, although as between them and the surety there was but one debt the application of the payments derived from the contract being one of the hazards the surety assumed. The question of the plaintiff's want of knowledge of the source of the money and good faith in making the appropriation to the payment of the unsecured debt being controlling issues, and the evidence thereon being conflicting it was held that the trial court did not abuse its discretion in granting the plaintiff a new trial, after judgment for the defendant, upon the ground of insufficiency of evidence.—B. F. Sturtevant Co. vs. Fidelity & Deposit Co. (Wash.), 158 Pac. 740.

CORRESPONDENCE

Heating With Exhaust Steam from Steam Hammers.

EDITOR HEATING AND VENTILATING MAGAZINE:

Referring to Reply No. 66 in the October issue of THE HEATING AND VENTILATING MAGAZINE, there is one point that I would like to have explained and that is the matter of rates. Assuming that exhaust steam is used entirely for heating purposes, with suitable meters on the condensation, which is returning through a vacuum system, how is the actual charge arrived at?

Pontiac, Mich. F. L. V.

As far as selling heat on the B.T.U. basis or by pounds of condensation is concerned, the units are interchangeable, so that it makes little difference which method is used. In rendering bills for heat, the cost and profit should be included, as with any other commodity, and a unit of measure used which is easily understood by the customer.

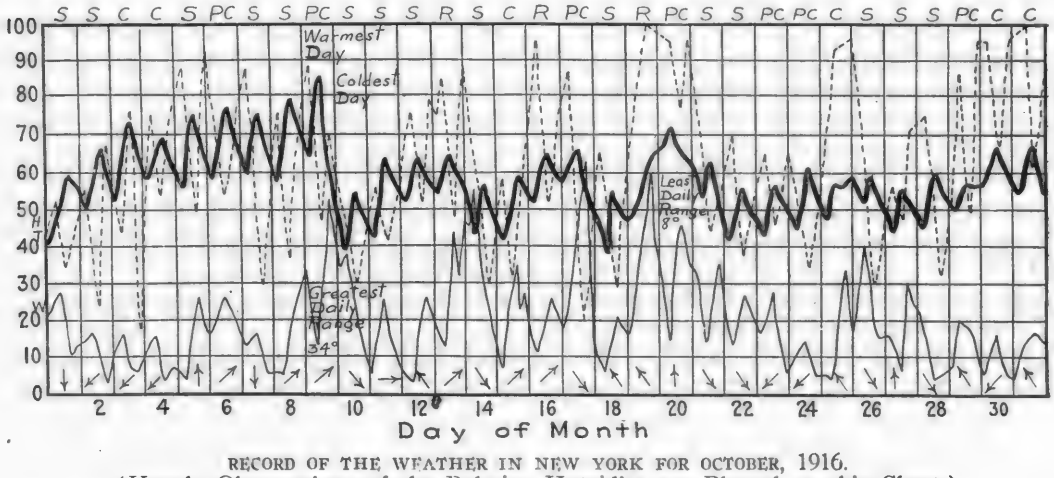
The common unit of measure would naturally be that in which the dial of the meter is calibrated. This is generally "pounds of steam condensed" because that is what the meter actually records. In using a condensasation meter care should be taken to set it properly before making the connections and also to test it in advance for accuracy. If not properly adjusted, this type of meter is apt to read "wild."

As far as rates are concerned, these, of course, will be determined by the costs, and in this connection it should not be assumed that because there is a surplus of exhaust steam at times the heating will cost nothing. Heating will probably be required at many times when there is no exhaust steam or insufficient, and live steam will have to be provided. From the writer's experience, 30 cents per 1000 lbs. of steam is about the cost in most places and a selling price of 50 cents per 1000 lbs. yields a fair profit. This is about a rate of $7.00 per ton of coal to the consumer, but there is no expense for boilers and labor of attendants.

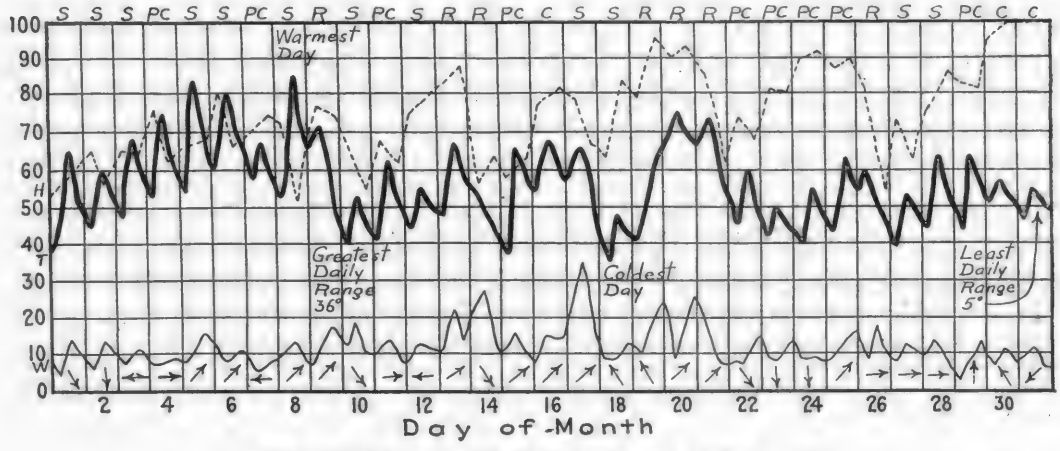
The Weather for October, 1916.

	New York	Boston	Pittsburgh	Chicago	St. Louis
Highest temperature, degrees F	84	84	86	87	86
Date of highest temperature	9	8	8	5	7
Lowest temperature, degrees F	39	36	33	35	30
Date of lowest temperature	10	18	23	26	21
Greatest daily range, degrees F	34	36	35	31	27
Date of greatest daily range	9	9	3	8	22
Least daily range, degrees F	8	5	3	3	7
Date of least daily range	20	31	21	21	15
Normal temperature for month, degrees F.	57.2	56	55	54.4	59.2
Normal mean temp. for month, deg. F.	55.6	52.3	54.9	53.2	58.4
Total rainfall, inches	0.63	0.94	2.31	3.88	1.64
Normal precipitation this month, inches	3.71	3.86	2.36	2.55	.41
Total wind movement, miles	11804	7489	7311	10208	9575
Average hourly wind velocity, miles	15.9	10.1	9.8	13.7	12.9
Prevailing direction of wind	N. W.	S. W.	W.	S. W.	S.
Number of clear days	15	14	15	*18	16
Number of partly cloudy days	7	9	4	6	8
Number of cloudy days	9	8	11	7	7
Number of days on which rain fell	4	7	10	*16	8

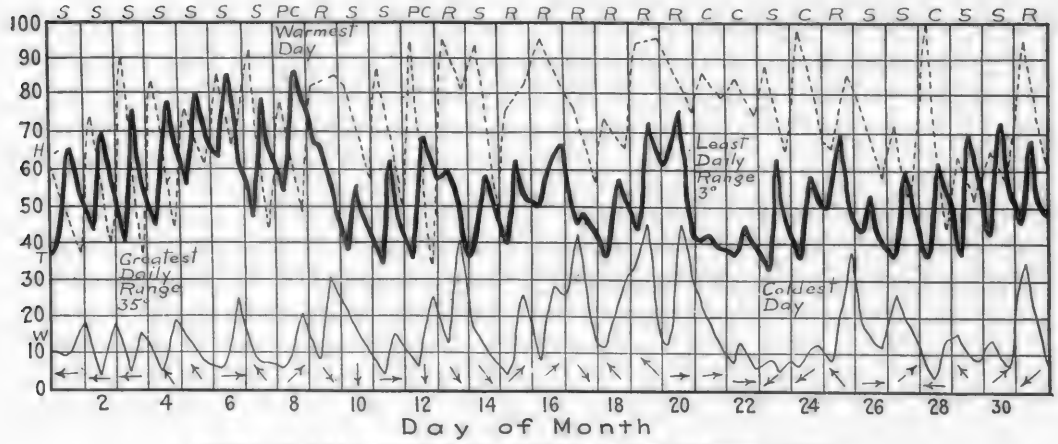
*Although 0.01 in. or more of rain fell on 16 days during the month, there were 18 days that were classed as clear, having 30% or less of cloudiness.



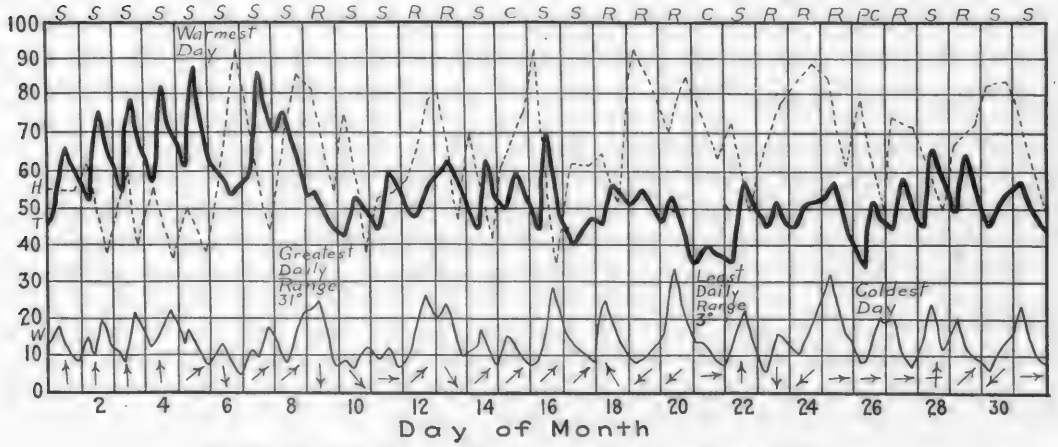
RECORD OF THE WEATHER IN NEW YORK FOR OCTOBER, 1916.
(Hourly Observations of the Relative Humidity are Plotted on this Chart.)



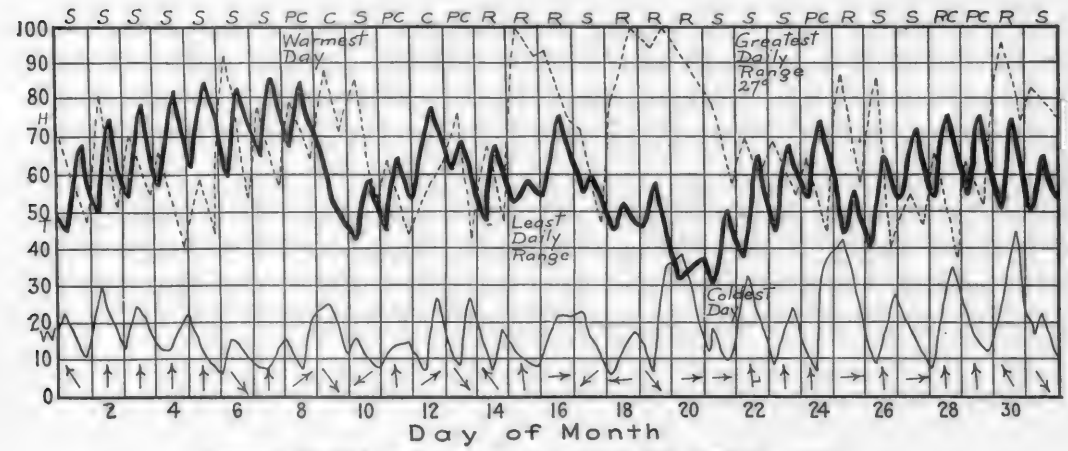
RECORD OF THE WEATHER IN BOSTON FOR OCTOBER, 1916.



RECORD OF THE WEATHER IN PITTSBURGH FOR OCTOBER, 1916.



RECORD OF THE WEATHER IN CHICAGO FOR OCTOBER, 1916.



RECORD OF THE WEATHER IN ST. LOUIS FOR OCTOBER, 1916.

Plotted from records especially compiled for THE HEATING AND VENTILATING MAGAZINE, by the United States Weather Bureau.

Heavy lines indicate temperature in degrees F.

Light lines indicate wind in miles per hour.

Broken lines indicate relative humidity in percentage from readings taken at 8 A. M. and 8 P. M.

S—clear, P C—partly cloudy, C—cloudy, R—rain, Sn—snow.

Arrows fly with prevailing direction of wind.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

New York Chapter Discusses New Type of Vacuum Heating System.

What is described as a "one-pipe down-feed vacuum heating system, eliminating traps, return valves and air valves on individual radiators," was the subject of an address delivered by Charles R. Ball, the inventor of the system, at the November meeting of the New York Chapter. The meeting was in charge of a special committee headed by A. M. Feldman, chairman, who was handed the gavel by President Arthur Ritter after the preliminary business had been disposed of. This included an announcement that the executive committee had appointed A. S. Armagnac to act as chairman of the chapter's entertainment committee in connection with the annual meeting of the heating engineers' society, January 16-18, 1917.

Before introducing Mr. Ball, Mr. Feldman gave an account of the development of the steam loop and the first return trap, invented by the late James H. Blessing, of Albany.

He then introduced Mr. Ball as one of the pioneers in the vacuum steam heating field whose inventions have contributed much to the advance of this art.

Mr. Ball began his address by stating that the air line and "tail end" vacuum systems constitute a very old art, in which the real drama is connected with the "tail end" system. It is the general impression he said, that the beginning of the art of vacuum heating practice was concurrent with the Williames patent (1882). He pointed out, however, that the use of the Blessings trap dates from 1870.

The Williames patent, both in drawings and specifications, refers to both a fan or pump for the exhausting apparatus, to extract the air only and receive the condensation in a tank or hot well. It shows on steam and return connections just the plain globe or angle pattern valves and refers to a cold water spray to condense vapors and cool the air, and also to pressure steam to force a circulation where no exhaust is available. All claims of this patent, segregated from the drawings, would apply to the surface condenser in common use at the time, all in accord with later court decisions.

It was the irony of circumstance, continued Mr. Ball, that the first installations of this system were made in factories, where there were large cooling coils of 1-in. pipe, from 125 to 150 ft. long, with four to ten pipes assembled. Formerly pressure steam direct from the boiler, throttled down at the inlet valve, had been used, blowing through a return, with a trap delivering to a hot well for return by feed pump. The inducement for revision then as now was the conversion of the exhaust without back pressure, and such results were obtained.

It is easily seen that the long travel of the steam and the relation of the areas of the small pipes to their surface enabled a most complete condensation of the exhaust some distance before it reached the end of the coils and that a considerable cooling of the condensation itself took place in the coils, thus eliminating all flashing and other troubles that arise from condensation containing too much sensible heat. Later on, however, it was attempted to use this system in buildings containing radiators in small units, and in those days, with solid bases of large areas and tubes superimposed, the vacuum impulse drew the steam through with great velocity, causing a short circuit to the return pipes and connections.

Traps of all kinds were in general use in those days, also the common air valve with an expansion member, so we made a diminutive trap to work thermostatically and applied it to the return outlet. The catalogue phrasing being "to allow the free escape of water and air, but prevent the wasteful escape of the vehicle," compelled us to acquire the Hall patent. In arranging for an initial vacuum sufficient to circulate the remote radiators, our velocities became so great that the condensation reached the pump with so much sensible heat that it flashed, that is, our condenser did not condense, so we put in a jet.

The hand adjustment of the steam valve to the pump and that to the jet could not be dependably arranged to preserve at all times the vacuum required. The pump would race with injury to itself and the jet would either be excessive or not sufficient, in which case the flashing lowered the amount of vacuum. The next step, therefore, was the vacuum controller, that compelled us to acquire the Hussey & McCann patent.

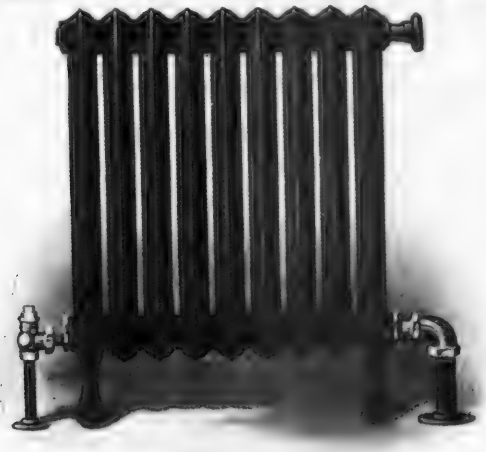
FEATURE OF THE VACUUM HEATING SYSTEM.

After a further discussion of the development of the art, Mr. Ball took up the description of his new system which is called the "Pres-Vac" system of steam heating. In this system use is made of the hot-water type of radiator. The first section is closed at the bottom with a solid nipple to shunt the steam up the first section to the controlling factional packless insert valve. The runout branch to the radiators is a single pipe in which the first nipple has areas suitable for the steam supply and the return, underneath

the steam, of the condensation back to the riser. From the drop tee noted, the pipe runs to and connects with the check on the return outlet.

On the riser below all surfaces is placed an extra heavy socket tapped for the thermo, and in the spring piece is inserted a swing check, the arrangement of which was shown. At the extreme end of the main return delivering to receiver of boiler feed pump, is a fitting termed A. R. Co. 525. The function of this fitting is to relieve at a few ounces pressure, close upon steam contact, and admit no re-entrance of air when the pressures are below atmosphere.

The circulation of steam through this system is downwards. The initial procedure, whether for tests or temporary heat, is to use



ASSEMBLY OF INSERT VALVE, RADIATOR AND ADJUSTABLE CHECK USED IN "PRES-VAC" SYSTEM OF STEAM HEATING.

such an initial pressure as will blow out the air through the fitting 525. The vacuum pump will be running, not necessarily for assisting the circulation, but preferably to test the adjustment of the thermos. Operating so, it is obvious that the air will be relieved quickly, and the steam will soon reach the thermos which, in turn, will close, allowing the vacuum to cut out the pump through the controller, with the preferred adjustment of 22 in. of vacuum.

Coursing downward, as each riser tee is reached, an equilibrium will take place in the connection and some air will relieve at the check. Steam will flow into the void and condense, closing the check until another equilibrium occurs. The recurrence reciprocally of this function will fill the radiator with steam to the base, the air and consequent condensation falling to the terminal points. At this point if the steam valve to any radiator should be closed, upon opening it the circulation will be affected as explained.

In order to meet varying ideas as to proper temperatures for comfort, the initial conditions must be such that those requiring less heat can get it by manipulating the fractional inlet valve. As these differing fractional volumes condense in the radiator, the lesser pressures close the checks accompanied by an upbuild of the water proportionately to the adjustment for the lesser steam volume. Upon opening the valve again, the retained water falls and causes a void, much after the manner of producing a barometric vacuum, into which the steam flows. This, according to Mr. Ball, is a better function than that in some vapor systems which provide that the air shall again enter under fractional uses, because the further relief of that air requires a pressure slightly in excess of that of the atmosphere.

One of the important features of this system, as explained by Mr. Ball, is its adaptability for operation under a wide range of pressures, making it possible to modulate the temperatures and prevent overheating by control of the initial pressure at its source. The regulation of the initial pressure may be obtained by the operation of a single valve, Mr. Ball explaining in detail how this is accomplished.

Regarding the function of the vacuum pump used with this system Mr. Ball emphasized the point that in no way and at no time does this pump operate to cause or maintain the circulation. After discharging the air at the fitting 525, by the few ounces of pressure required, and after that fixture closes by steam contact, the system could be operated indefinitely and at any desired pressure. The pump is a dry air pump and as such must have a small amount of water to seal the valves. The air separating tank is used to furnish the sealing water. Each discharge of the pump delivers this water again to the tank, to be used continuously as described.

The importance of having the riser entirely free of air at all times and filled with vapor and steam to enable the air to fall by gravity to the terminal points is the prime reason for the use of this pump. It is also intended for use when the system is operating at and considerably below atmospheric pressure, and at times when it would not be convenient to raise the pressure to that required for a mechanical air relief at fitting 525. Obviously, this can be a very small pump.

Vapor Heating Discussed by Illinois Chapter.

Vapor heating, with special reference to its use in central station heating work, was the subject of a talk by Lloyd Howell, of the American District Steam Company, given at the November meeting of the Illinois Chapter.

This meeting was held November 13 at the Engineers' Club, in Chicago. The address followed a dinner and smoker, with President Fred W. Powers in the chair. The treasurer, August Kehm, reported a balance of $311.

Mr. Howell, who was then called upon, gave his hearers some interesting facts as to the methods used in central station heating work, including the use of vapor heating. The usual central station heating plant, he said, delivers steam through the street mains at a pressure fluctuating from 1 to 5 lbs., depending on the weather. Where the connection is made for the supply piping system for a building, a simple pressure regulating valve is used and a U-tube mercury gauge to determine the pressure on the low side of the valve. The customary setting for the delivery is 6 oz.

Mr. Howell said that it was customary to furnish 25% surplus radiation in buildings using central heating service, the extra radiation being used to remove as much heat as possible from the condensation. As a result the temperature of the condensation is about 90° F. and often lower.

Over fifty members and guests attended the meeting.

Eastern Pennsylvania Chapter.

"Open Air Schoolrooms" was the topic of the evening at the November meeting of the Eastern Pennsylvania Chapter, which was held at the Engineers' Club, November 9. The principal speaker was Dr. Walter Roach, of the Philadelphia Bureau of Health.

After outlining the necessity for open air schoolrooms and the advantages to be derived from their use, Dr. Roach illustrated the work being done in Philadelphia in this direction by means of motion pictures. An interesting discussion followed the presentation of the paper. Among the chapter's guests were Secretary C. W. Obert of the heating engineers' society and James A. Donnelly, of New York.

Michigan Chapter Gets Furnace Heating Data.

A carefully-prepared paper on furnace heating was presented at the November meeting of the Michigan Chapter which was held at the Fellowcraft Club, Detroit, November 13. The paper was presented by J. M. McHenry and included data regarding results of tests conducted by Messrs. McHenry and Davenport at the Detroit Stove Works. The paper was generally discussed.

The meeting was largely attended, President John R. Allen being in the chair. Action was taken on the question of the control by the city of chimneys and flues used for heating apparatus, the chairman appointing the following committee to confer with James C. McCabe, chief boiler inspector of Detroit: F. K. Boomhower, R. S. M. Wilde, E. L. Downs and E. J. Lomasney.

J. E. Degan was appointed to take charge of the trip of the members of the Michigan Chapter to the annual meeting of the society in New York in January

The subject for the December meeting which was scheduled for December 11, was "Direct and Indirect Heating Systems."

NATIONAL DISTRICT HEATING ASSOCIATION

Dates Selected for 1917 Convention.

The ninth annual convention of the National District Heating Association, it is announced, will be held in Detroit, Mich., June 12-15, 1917. Headquarters will be at the Hotel Pontchartrain. The announcement is issued by President Byron T. Gifford and Secretary D. L. Gaskill "to the members of the National District Heating Association and all interested in district heating."

American Society of Mechanical Engineers.

A large attendance and full discussions marked the annual meeting of The American Society of Mechanical Engineers, which was held in New York, December 6-9. In addition to the general sessions there were industrial safety, textile, machine shop, valuation, gas power, railroad and steam boiler sessions. During the Wednesday session, December 6, a paper was presented of general interest to the heating trade on "The Testing of House-Heating Boilers," by L. P. Breckenridge and D. B. Prentice. This paper attracted considerable discussion which will be presented in a later issue. The paper itself, as well as another paper read at the Wednesday afternoon (textile) session by Arthur N. Sheldon on "Heat Transmission Through Various Types of Sash," will be found on other pages of this issue.

The election of officers resulted as follows: President, Ira N. Hollis, Worcester, Mass.; vice-presidents (for two years), Charles H. Benjamin, Lafayette, Ind.; Arthur M. Greene, Jr., Troy, N. Y.; Charles

T. Plunkett, Adams, Mass.; managers (for three years): Robert H. Fernald, Philadelphia, Pa.; William B. Gregory, New Orleans, La.; C. R. Weymouth, Berkeley, Cal.; treasurer: William H. Wiley, New York.

How to Sort and Preserve Technical Periodical Literature.

A salient feature of the Detroit Edison Company library, says a writer in *Special Libraries,* is what is termed a technical periodical service. In meeting individual members of the organization, I found a general sentiment among them of their sheer inability to keep informed thoroughly of the current trend of their particular line of interest and a keen enthusiasm for any method which would give them the assurance that their interests were being watched and items of special importance brought to their attention. In this connection I have built up a schedule of the interests of the various individuals of the company, and through the company publication have announced that upon request this service will be extended to any person who will thereby receive automatically such articles as interest him whenever they appear. This service brings directly to his desk the gleanings of one hundred thirty picked journals. Individuals may have their names entered to the mailing list to receive regularly those journals which they particularly wish to examine as issued; these are sent to their desks, if desired, with the request that they be returned at a specified date, depending upon the demand for the journal. A date signal is placed on the card which carries the charge and prevents it from being held unduly long on any desk.

THE PRESERVATION OF ARTICLES OF VALUE

The matter of preserving published articles is one which demands thoughtful treatment. I personally examine all of the journals, including those of French and German publication, that come into the library. In estimating an article I consider whether it is of remote or immediate interest. In the case of the article which deals with a subject that the company might be interested in at some distant time, the time necessary to look it up would be of negligible concern to the person requesting it. Articles of this type are readily available through the several periodical indexes, and a business library does well to avoid this unnecessary duplication of effort. On the other hand, if the article is of such a character as to make it desirable to place it at the disposition of any individual at a moment's notice, a card is placed in the catalog bearing the citation. The card used for this purpose is of a special form, drawn up for the purpose of reducing the amount of typing to a minimum.

TITLE .....
AUTHOR .....
JOURNAL .....
Date..... 19... Page..... Vol.....
Comparative ..Descriptive..Experimental..
Historical... Mathematical... Practical...
Illustrations.. Tables.. Curves..

After considering the article from this angle, the particular article is directed to the list of persons which the schedule shows are interested. Frequently, if it is an article of general interest, it is directed to a responsible person with the request that it be circulated to all those in his department who may be interested. In this connection I might mention the point that valuable specific items are frequently to be found in articles which are general in their treatment and which in many cases are not analyzed in the regular periodical indexes; such data should of course be noted in the library catalog.

Current Heating and Ventilating Literature.

Under this heading is published each month an index of the important articles on the subject of heating and ventilation that have appeared in the columns of our contemporaries. Copies of any of the journals containing the articles mentioned may be obtained from THE HEATING AND VENTILATING MAGAZINE *on receipt of the stated price.*

HOT-WATER HEATING

Hot-Water Heating at Plant of the Crane Co., Chicago. Thomas Wilson. Ills. 2000 w. Pwr—Sept. 12, 1916. Serial, 1st part. Modern system of seven circuits to care for 600,000 sq. ft. of radiation in 49 buildings. 20c.

A Successful Hot Water Heating System. J. C. Hawkins. Ills. 2,000 w. P E, C—Oct. 1, 1916. Scheme for heating office building. 20c.

Warm Air Heating and Sheet Metal Journal is the new title of the *Sheet Metal Contractor's Journal.* This magazine was formerly published by Edwin L. Seabrook, secretary of the National Association of Sheet Metal Contractors, but has recently been taken over by the association itself and will be developed as strictly an association organ, the purpose being to make the journal the business magazine of the sheet metal trade.

Purification of the Air by Electricity.

A scheme for removing dust and germs from the air, known as electrical precipitation, has recently been perfected in America, based on an idea originating in Germany. Electrical precipitation it is known, takes place on an enormous scale in Nature, the downfall of rain and with it dust, after a flash of lightning, being a familiar example.

Electrical precipitation is described by a writer in the Electrical Review as a mode of charging rust and the finest atoms of matter, whether mineral or vegetable, with electricity, and of causing them to fall or be precipitated upon a plate or vessel or tank, as it may be called, which is known as the precipitator. It is a kind of giant vacuum cleaner. The electric current is the agent of this precipitation. By this force each grain of dust or matter is charged with the same kind of electricity, which sets each particle in rapid motion and causes the whole mass of these small and even tiny atoms to concentrate on the precipitator, which thus collects them in a layer. In this way the dust of a room, a theatre, a railway car or factory, and even the open air, is made to settle upon a surface or in a series of tubes and pipes. These precipitators have been installed in various buildings.

They pay a good return on the investment of money required. For example, in ventilating modern public buildings and uptodate factory buildings it is considered desirable to control the temperature and humidity of the air and remove all dust, bacteria or germs. In one recent installation it was found that by circulating a large quantity of air by electric currents in a closed system, by thus removing the dust and moisture by electrical precipitation, the saving of steam which would have been required to dispel the moisture and the dirt by heat in cold weather paid a high return on the money spent.

This method is obviously of great value in sanitary cleaning. The necessary plant appears to be fairly easy to use for purifying the air either of rooms or of open spaces. Some way of cleaning the places where the germs of epidemic diseases collect and multiply is urgently required. The germs of infantile paralysis, for instance are carried in ships, in trains, in subways; they grow in tenements on garbage and refuse, and they seem to be especially active in summer, when dust is plentiful and is blown about in the streets and into houses through the windows. These germs are fatally likely to exist in the waste products of the human body, in the secretions of the mouth and nose, and any fight to a finish with such enemies must require all our resources. We are all agreed that such measures are necessary, but we are curiously inconsistent in the way we neglect the engineering side of these problems.

Vent Hoods of the Internal Cone Type.

Two interesting types of vent hoods, with internal cones, are illustrated herewith, the hood shown in Fig. 1 being designed for use when exposed above the roof, that shown by Fig. 2 for use when installed in a cupola. Because of their exposure to the elements, these hoods should be constructed of galvanized iron of two gauges heavier than ordinary sheet metal work which is installed of equal size, though preferably these should be of 20 oz. copper (30 oz. in large sizes), with copper rivets used in making up the copper work.

The inner cone should be larger in diameter than its connection to the duct work, in order to prevent rain or melted snow from entering the ventilation system. The ¾-in. lipped edge, as shown in the sketches, is used to direct the water directly downward, thus preventing it from traveling inward to the lower apex of the inner cone. With a cone of the type shown in Fig. 2 it is necessary to install a 1¼-in. or 1½-in. galvanized iron drain line connecting from two points, as shown, and extended from these points to the nearest inside rain water conductor. Both drains of smaller size and those discharging directly open above the roof are liable to freeze solid. Where carried inside they are somewhat protected from freezing and are also heated by the exhausted air. With a cone of the type

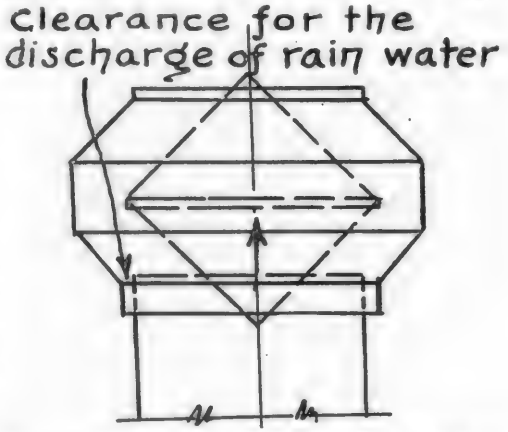


FIG. 1.—VENT HOOD DESIGNED FOR USE WHEN EXPOSED ABOVE ROOF.

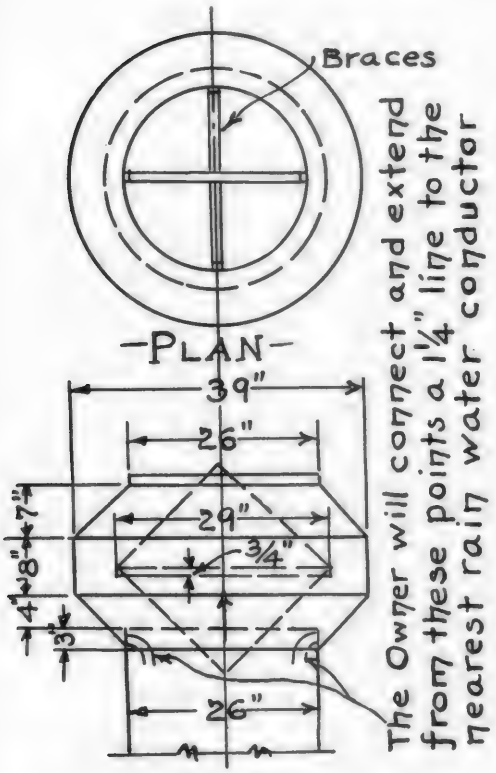


FIG. 2.—DESIGN OF VENT HOOD FOR USE IN A CUPOLA.

shown in Fig. 1, the discharge of entering water may be effected, as shown, by a clearance around its entire circumference.

The clearance between the inner and outer cones should be of a free area, equivalent to their connection to the system. In some systems, though the exhaust fan is run intermittently, it is nevertheless desirable that the air be exhausted for ventilation purposes by gravity to as great an extent as possible from the various rooms to which connections are made. In such cases the free area through the cone, together with its connection, should be of a greater area. The sloping sides of the cone are constructed at angles of 45°, and this, together with the required free area and greater diameter of the inner cone, as previously explained, determine the dimensions of the vent hood. The hood should be braced, as shown in plan.

Should the vent hood be used in connection with the exhaust of vitiated air from an abattoir, it is necessary that the top thereof be completely covered with a 14 to the inch square mesh copper wire screen, set in a removable frame. This prevents the entrance of flies, and for the same reason it is best to use a vent hood of the type shown in Fig. 2, which eliminates the opening around its circumference for the discharge of water, as shown in Fig. 1.

The Application of Gas to Steam Boilers.

That the gas interests are rapidly waking up to the opportunities in connection with gas-fired steam boilers, especially in the industrial field, is demonstrated by the recent publication of Industrial Fuel Reference Book No. 3, which is entirely devoted to this subject. The book is published by the National Commercial Gas Association, 61 Broadway, New York. The information has been compiled with the definite view of giving the gas appliance salesmen information necessary for the sale, actual installation and upkeep of gas-fired steam boilers. Some of the better-known makes are described, including the Ofeldt, Kane, Schmitt, Automatic, Economy, Triumph, Electric Weld, Freymark and Scientific boilers.

Under "Applications of the Gas-Fired Steam Boiler," it is stated that these applications are of an exceedingly diverse and extended nature. They are classified as high pressure where the steam pressure exceeds 15 lbs., per square inch, and low pressure where below this figure. Another method of division is to designate the systems as open or closed. Practically every industry, it is stated, offers opportunities for the use of the gas-fired boiler.

Under "Advantages" is mentioned first the efficiency which, it is stated, is considerably higher than that of the boiler using solid fuel. Cleanliness is also emphasized as well as the smaller space taken up by the gas-fired boiler. In addition the gas boiler can be set near the work, which is often on the upper story of a building, where it may be inconvenient to supply coal and remove ashes. This means a saving in expense of installing steam pipe and a saving in fuel, because the radiation from long runs of steam pipe is eliminated.

The labor saved is also important, as when working on a closed system, for instance, or with an automatic feed water regulator very little attention is required, and the services of one man can often be saved, besides the handling of the fuel and ashes.

Gas-fired boilers, it is pointed out, are equipped with automatic devices which cut down the gas supply when a predetermined steam pressure is reached. This means constant pressure, besides a saving in fuel,

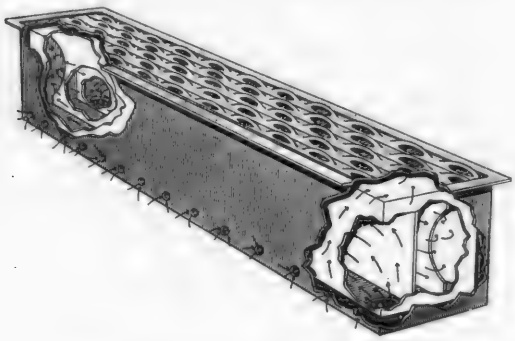
Still another point brought out is that steam can be very quickly raised in a steam boiler, while the application of the boiler to intermittent uses of steam is one of its greatest advantages. Finally, the gas boiler is exceedingly well protected against accident, being practically fool-proof in this respect.

The ensuing pages contain some interesting matter in the way of practical questions and answers regarding steam boilers, feed water problems and steam pumps. A list is also given of some of the uses for gas-fired steam boilers the book concluding with descriptions of various accessories, such as gas regulators, water feeders, including pumps and injectors and steam traps. Size 6x9 in. Pp. 119. Price 50 cents.

NEW DEVICES

Blackwell Auto Exhaust Heater.

A new exhaust heater for automobiles which is designed to take the place of the muffler, has been brought out by the Dayton Welding Co., Dayton, O. It is intended to be placed between the front and rear seats of the five or seven-passenger car. The heater is 24 in. long by 4¼ x 4¼ in. It is made of heavy-gauge pressed steel, every seam and joint being welded, to make it fume-proof. The heater is constructed of two steel boxes. The inner box has three partitions and the heat travels 6 ft. on the inside of the inner box before being discharged. The outer box is made with ½-in. air space on all sides and is covered on the inside with asbestos, cemented to the inside of the outer boxing. This leaves ⅜-in. air space next to the inside box which communicates with holes on the front bottom edge of heater, allowing the fresh air to pass in and forcing the hot air out into the car.



BLACKWELL AUTO EXHAUST HEATER.

ANDREWS GARBAGE BURNER AND WATER TANK HEATER, for apartments, hotels, hospitals and residences, has been brought out by Andrews, Minneapolis, Minn. The garbage is fed in at the upper door and is dried and burned as it travels down the brass spiral stairway grate, made of brass water tubes. The oil and grease in the garbage give off an intense heat as they burn, which is utilized in heating the water. It is stated that from 30% to 50% of the fuel can be saved over the amount required with an ordinary tank heater. The heater itself occupies a floor space from 22 in. to 34 in. diameter, depending on the size selected. The brass spiral stairway grate is the exclusive feature of this garbage burner and heater. It is arranged with a by-pass for the free escape of smoke, moisture and gases from fresh garbage.

ANDREWS GARBAGE BURNER.

TOP SECTIONAL VIEW SHOWING LARGE HEATING SURFACE IN BRASS WATER TUBE SPIRAL STAIRWAY GRATE.

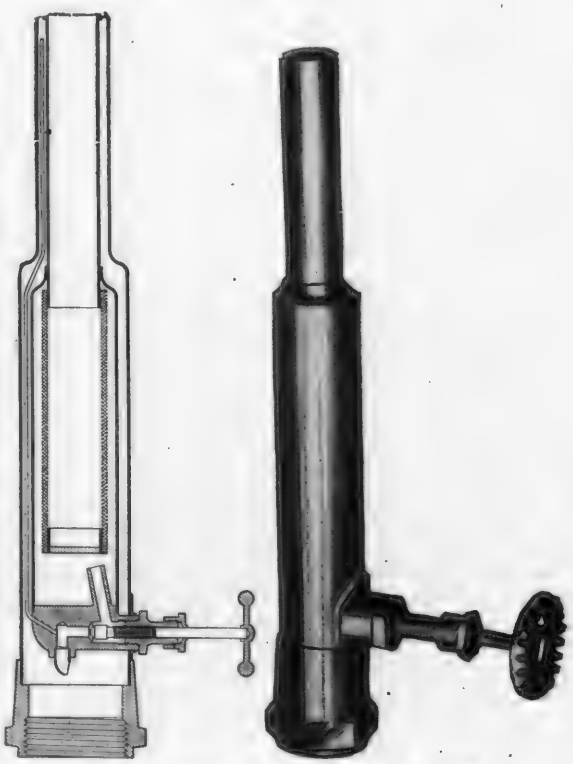
A Handy-Operating Cutter.

The usual way for making an additional hole in a cabinet for accommodating a piece of conduit or for making a hole in metal lockers, has been a source of considerable trouble. The accompanying illustration shows a new, easily-operated tool, invented by a Milwaukee man, Mr. Bach. This device can be used for cutting all sorts of metal, fibre and slate, and can be adjusted so as to cut holes of various sizes with little effort. To use the tool, a pilot hole is first drilled through the material and through this is passed the stud. A flange nut is then secured on the opposite side of the stud and a ratchet wrench used to cut the hole. This cutter is known as the "Jiffy" and is being manufactured by the Universal Tool and Appliance Co., Milwaukee, Wis.

SHOWING USE OF NEW "JIFFY" CUTTER.

Trade Literature.

STEAMO AND VAPO AIR MOISTENERS, for steam, vapor and vacuum heating systems, are featured in a new catalogue issued by the Air Moistener Co., 28 North Market Street, Chicago, Ill. These devices are designed to discharge steam or vapor silently in a dry state directly from the steam pipe or radiator into the room. The point is emphasized that there is no question of their working as the operation is not hidden, the issue of the moisture and its absorption occurring in plain sight. The Steamo air moisteners are for use with the



INTERNAL VIEW SINGLE PIPE TYPE. SINGLE PIPE TYPE.

ordinary steam systems, and the Vapo moistener for vapor and vacuum systems. Neither device can be used with hot water heat. The full line includes the radiator type, single-pipe type, riser type and double pipe type, each in two or three sizes. Directions are also included for connecting and operating each type. Size 5½ x 8½ in. Pp. 12.

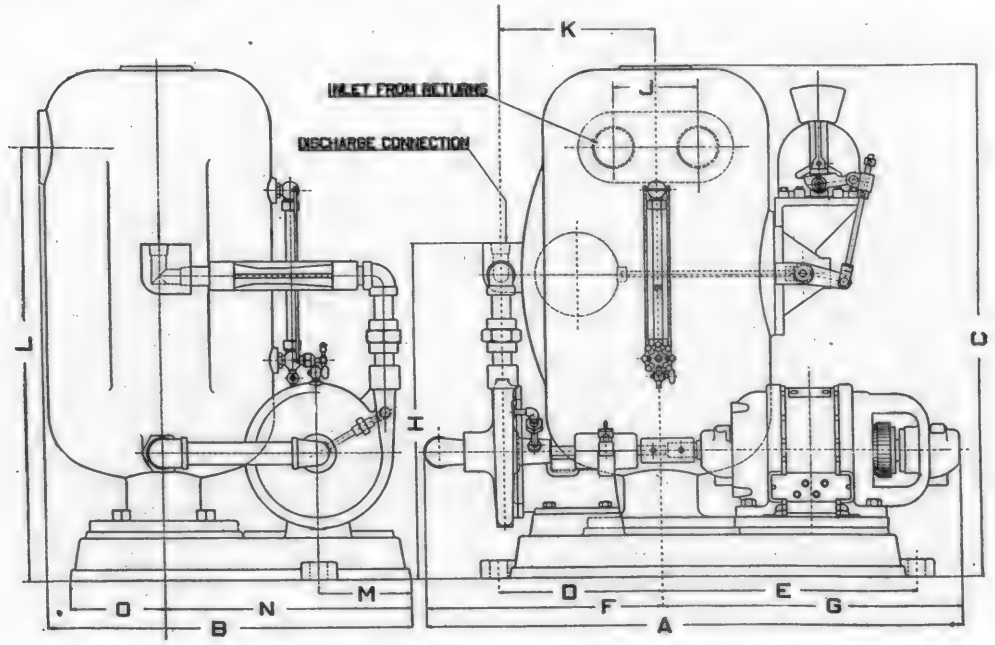
A Day's Work, comprising "a series of disjointed talks to the employees" of the United States Radiator Corporation, Detroit, Mich., is a booklet well worth reading. It is intended to convey the code of efficiency which the management considers essential to the successful conduct of its business. Size 3½ x 6 in. (standard). Pp. 20.

Advance Condensation Pump and Receiver, automatic and motor driven, made in two types, is an interesting product of the Advance Pump and Compressor Co., Battle Creek, Mich., and described in a recently-issued catalogue. This outfit includes an over-hung centrifugal pump, motor-driven, mounted on the same cast-iron base plate with the vertical cast-iron receiver tank, and has automatic switch control and non-overloading safety device. The discharge of the pump is connected through a pipe to suitable boss cast on the receiver tank, and the suction inlet of the pump is also connected by piping to the receiver. One of the principal points mentioned for this apparatus is that the motor and pump cannot get out of line. The bulletin (No. 205) includes detailed specifications and there is also a table of standard sizes for

ADVANCE CONDENSATION PUMP AND RECEIVER.

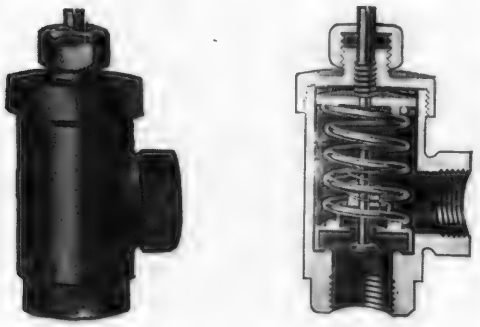
the two styles, under four different conditions of service. Size 6 x 9 in. (standard). Pp. 8.

Nefco Heating Specialties, including the Nefco automatic vacuum-vapor heating system, Nefco radiator regulating valve and Nefco heat generator, are featured in a recent catalogue issued by the N. E. Frost Co., 231 Insurance Exchange, Chicago, Ill. The Nefco heat generator is for use with hot water heating systems. It can be placed anywhere on the line to the expansion tank and is set against a 10-lb. pressure, so that it operates to confine the water in the system until a pressure of 10 lbs. is created above the natural pressure of the water in

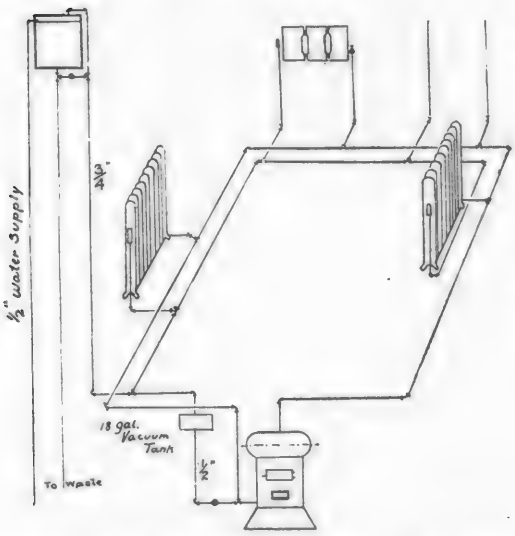


CONSTRUCTION OF ADVANCE CONDENSATION PUMP AND RECEIVER.

the system. The more rapid circulation obtained permits the use of one size smaller radiator valves and connections from main than with the open-tank system. The device itself is made of brass. The springs are of phosphor bronze. Although adjusted to operate at 10 lbs. pressure, these generators can be readily set for 25 lbs. pressure for the tank-in-basement system. Size 5 x 7¼ in. Pp. 14.



EXTERIOR AND SECTIONAL VIEW OF THE "NEFCO" HEAT REGULATOR.

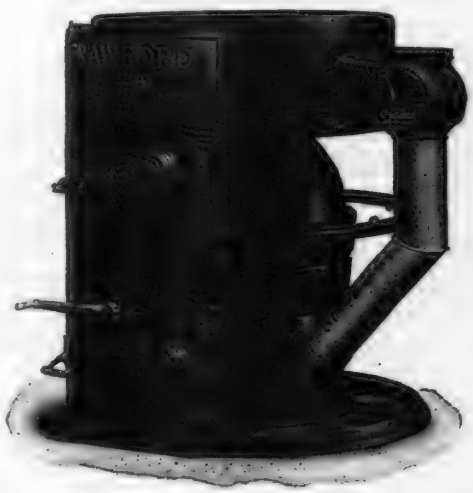


NEFCO AUTOMATIC SYSTEM APPLIED TO HEATING PLANT.

THE BEIGHLEE SYSTEM, COMPENSATED, is the title of a new bulletin issued by the Beighlee Electric Co., Cleveland, O., devoted to "the pyrometer that has set a new standard." The Beighlee pyrometer system is the invention of H. E. Beighlee and, it is stated, will be found to successfully overcome the errors of the ordinary types of pyrometers, such as the temperature coefficient error, the cold junction error and the lead resistance error. The operation of the Beighlee system is described at length, the text being accompanied by many illustrations. Size 6¾ x 10 in. Pp. 28.

NATIONAL TUBE CO., Pittsburgh, Pa., is sending out Correction Sheet No. 2, applying to Catalogue J-1915, devoted to the Kewanee products of the company. The changes refer principally to the sizes of close nipples, a new pattern of No. 6 boiler coupling with union, additional sizes of National flange unions, and new data on National spring plug cocks.

CRAWFORD FURNACES, 200 SERIES, for warm air heating, are a new and unique product of the Walker & Pratt Mfg. Co., Boston, Mass., which are the subject of a special catalogue. The most prominent feature of this heater is the single damper which regulates the ashpit draft, the smokepipe opening, as well as the smokepipe check from the cellar. A single flap revolving inside the damper shuts and opens the four openings in exactly the proper proportion. The furnace is not a down-draft furnace in any sense of the word and cannot be used as such, although the presence of a pipe on the side of the ashpit tends to give that impression. The dome is cast-iron without any openings or joints. The cleanout arm is on one side and the smoke arm on the other. Halfway between the inner and outer dome is suspended a vertical sheet of iron which is an application of the well-known physical principle that a solid will heat by radiation, while air will not. This sheet is heated by radiation from the inner and outer surfaces of the dome and then



NEW TYPE OF CRAWFORD WARM AIR FURNACE.

gives up its heat to the air by contact. The furnace is so designed that most of the air is forced inside the dome in close contact with the feed section. The fire-pots have heavily-flanged joints. In this, as in some other Crawford warm air furnaces, use is made of a new gear-down construction in connection with the grates, a small gear being mounted on the shank which revolves the larger gears attached to the grate. This permits the grate bars to be made shorter, and keeps the ends of the bars away back from the ashpit door, making it easy to remove the ashes and to shake the furnace. The doors are surfaced by a special machine to give a very tight joint. The latches and hinges are small pieces readily bolted on and changed in case of breakage. This heater is made in four sizes. Size 6 x 9 in. (standard). Pp. 8.

THE GUIDE TO FRESH AIR is the title of a folder recently put out by the Ohio Blower Co., Cleveland, O., which describes the Swartwout rotary ball-bearing ventilator and contains some interesting data on ventilation. It gives tables of ventilator capacities in cubic feet of air per minute, and dimensions, weights, gauges, etc., of

standard ventilators, with a detailed description of their construction. Special attention is given to the glass-top type which combines the functions of skylight and ventilator. The skylight is self-cleaning and no position of the dampers can obstruct the light, when stormy weather necessitates their partial or entire closing. The Swartwout ventilator is mounted on ball bearings. The fact that but one 90-degree turn is made by the air as it is sucked out of the building by the outside breezes is mentioned as one of the important reasons for its high efficiency.

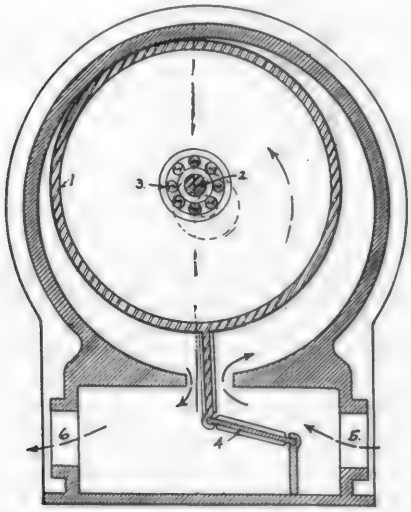
GURNEY DOWN-DRAFT BOILERS, for soft coal, are described and illustrated in a recently-issued circular by the Gurney Heater Mfg. Co., Boston, Mass. These boilers embody all the well-known features of the Gurney Bright Idea water-tube construction, with the addition of a water-tube grate and down-draft principle. The upper grates, it will be noted from the illustration, are hollow and filled with water, which, with the tubes immediately below them are entirely surrounded by fire. The upper grates are of unique and powerful construction. They are cast separate from the boiler and are screwed into the sections. The tubes composing the active heating surfaces are also screwed into the sections with fine machine threads and are made

GURNEY DOWN-DRAFT BOILER FOR SOFT COAL.

with internal diaphragms to insure rapid and positive water circulation. They are also designed to prevent conflicting currents of water, insure a steady water-line and permit rapid transmission of steam to the piping and radiators. The construction of the upper grates and tubes makes renewal easy, in case of breakage or accident. The circular contains full dimensions, etc., for both steam and water ratings in eighteen sizes. Size 9 x 11 in. Pp. 4.

DAVIDSON PROPELLER FANS, which are now made by the Davidson Fan Co., Newton, Mass., this company having acquired from the Massachusetts Fan Company, its rights, good-will and materials, are the subject of a newly-issued circular. These fans, it is stated, are especially useful for ventilating schools, theatres, factories, hospitals, offices, dye houses, bleacheries, etc. Suggestions are included in the bulletin for figuring capacities and other items, and these are followed by capacity tables, for free delivery and for restricted delivery. Size 3½ x 6¼ in. Pp. 16.

McALEAR SYSTEM, described as the biggest forward step in the science of steam heating, is the title of the latest catalogue issued by the McAlear Mfg. Co., 223 West Erie St., Chicago, Ill. This publication is described as not merely a catalogue, but a ready reference book on the McAlear system of vacuum and vapor heating, prepared as the result of 25 years' actual experience. The manual is profusely illustrated, great care having been given to the preparation to the sketches to make them thoroughly clear to the reader. The McAlear electric air line vacuum pump is one of the most interesting features of this system, containing a single propeller which rotates on ball bearings, displacing the air with a rolling motion, eliminating all friction and rubbing surfaces. When in operation, it is stated, neither steam nor water is required to seal these pumps. They are provided with an automatic vacuum controller, starting up when the vacuum drops to 5 in. on the air line and automatically cutting off when the vacuum reaches 10 in. After describing this and the other devices used with the McAlear system, such as the McAlear thermo vent automatic air valve, the Sparks automatic vacuum pump, the McAlear Perfection radiator trap and the McAlear packless graduating valve, the catalogue presents detailed descriptions of the McAlear two-pipe and vapor systems, with numerous drawings of installation details. Size 6 x 9 in. (standard). Pp. 64.



1. Impeller.
2. Crank shaft.
3. Ball Bearings.
4. Hinged Wall.
5. Inlet
6. Discharge.

PRINCIPLE OF MCALEAR ELECTRIC AIR LINE VACUUM PUMP.

RESULTS is the title of a booklet devoted to the Eastman heating system and published by the Eastman System Co., successor to the Eastman Heating Co., 235 Congress St., Boston, Mass. The Eastman system is two-pipe throughout, but uses only one radiator valve. The condensation from each radiator is taken care of by the Eastman automatic plug float valve. This float, being in the radiator, does away with the chambers on the outside of the radiators for floats. This valve is open to air and water, but closed against steam, so that there is no steam in the return risers or return mains. The returns are carried above the water line of the boiler and when the pressure drops the condensation all returns to the boiler, leaving the returns dry. No air valves are used with the Eastman system. The radiators or coils are relieved of air through the return pipes and thence through a vacuum controller to the chimney. The vacuum controller, through which the air is discharged, closes against vacuum and so operates that when pressure is lost at the boiler, a vacuum is formed throughout the entire system. This vacuum draws the vapor from the boiler through the system, retaining the heat in the radiators as long as there is any vapor. When installed on large work, all water of condensation is returned to the boiler through a specially-constructed trap. The circular also presents some of the shortcomings of one and two-pipe systems as generally installed. Size 4 x 8 in. Pp. 8.

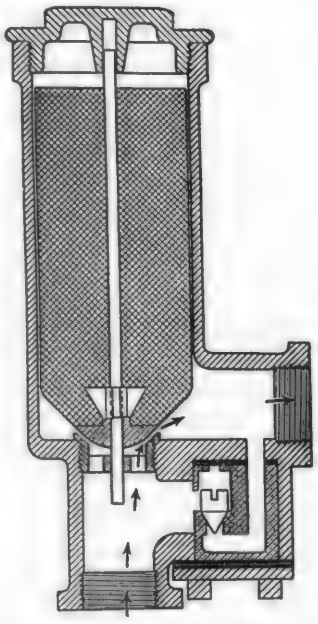
SPRACO PAINT GUN for all kinds of painting, including the painting of radiators, sheet metal work and tanks, is an interesting device illustrated and described in a circular published by the Spray Engineer-

THE SPRACO PAINT GUN.

ing Co., Boston, Mass. The complete equipment consists of a paint gun proper connected by flexible hose to a portable unit combining the material container, air dryer and strainer, pressure control attachment and pressure gauge. After the portable control head has been adjusted to meet the conditions of air pressure, thickness of paint, etc., the operator has control of the outfit by means of the trigger on the paint gun proper. The unit is furnished ready for attachment by a single hose connection to the compressed air supply.

KEELER WATER TUBE BOILERS, manufactured by the E. Keeler Co., Williamsport, Pa., are the subject of a new and well-prepared catalogue. The company, which is in its 53rd year, states that these boilers are offered to discriminating steam users as the produce of over 50 years' experience in constructing boilers of all standard types. The extreme care used in the construction of these boilers, it is added, can only be appreciated by a visit to the company's shops or by an inspection of the completed work. An interior view of the company's standard type is presented with descriptive details of construction and equipment and this is followed by "the argument" which starts off with the claim of superiority of wrought-iron over cast iron or steel for every part of the boiler under pressure. Pages are given up to a discussion of tubes, drums, headers, and baffling, followed by notes on dry steam, circulation and "Requirements of a Modern Steam Plant." The catalogue is profusely illustrated with typical Keeley installations. A series of twelve tests are tabulated in detail and contain some impressive figures regarding the efficiency of the Keeler boiler. The concluding pages take up the cross drum type boiler, the Keeler return tubular boiler, and castings and fixtures. Size 7½x10½ in. Pp. 45.

CLARK TEMPERATURE BOOSTER, manufactured by W. E. Clark, Ltd., Toronto, Ont., is an unusual device described and illustrated in a recent catalogue issued by this company. The company holds the United States patent, as well as the Canadian patent, and would dispose of the United States patent on suitable terms. The booster, which is intended for use on hot water heating systems, creates a pressure of 15 lbs. on the water contained in the system, causing a more rapid circulation and making possible the use of smaller piping. This extra pressure is accomplished by the weighted valve within the booster. The brass by-pass cage is removable, providing an effective means of freeing the valve of sediment or dirt at any time. The top-shaped check valve and its seat are also removable from the brass by-pass and its cage. The cylindrical case



CONSTRUCTION OF CLARK TEMPERATURE BOOSTER.

of the booster is made of brass, tapped for 1-in. pipe connections and reinforced at the tappings for additional strength. The weighted valve also has a brass seat, as well as a brass bearing placed in the opening at the bottom of the case, preventing corrosion and assisting perfect seating. Size 3½ x 6 in. (standard). Pp. 12.

STURTEVANT PNEUMATIC COLLECTING AND CONVEYING SYSTEMS, comprising fan systems for collecting dust and conveying materials, are treated in an impressive bulletin (No. 235 of the Sturtevant Engineering Series) issued by the B. F. Sturtevant Co., Hyde Park, Mass. After presenting the advantages of the pneumatic systems, the catalogue takes up the requirements of various processes, such as wood working, handling dust from tumbling barrels, and sand blast machines, cement plants, and conveying fibrous materials. This is followed by a presentation of Sturtevant apparatus adapted for these purposes, illustrated, in many cases, with views of typical installations, as well as with views of the apparatus itself. Rules are given in detail for the design of dust-collecting systems and this is followed by 13 pages of useful data tables. Size 8¼ x 11 in. Pp. 76.

STURTEVANT AUTOFORCE VENTILATORS are the subject of special circular matter which is being sent out by the B. F. Sturtevant Co., Hyde Park, Mass. These ventilators, it is claimed, will displace three times as much air under the same conditions as stationary ventilators of the same size and double the displacement of the regular cowl ventilators. They work on the principle of the steam injector or Hancock inspirator. Any size, it is stated, will be furnished to meet requirements.

DOWN-DRAFT SYSTEM OF SMOKELESS COMBUSTION, featuring the product of the Prudential Heating Co., Akron, O., is treated in an interesting manner in a new catalogue issued by this company. As one of the pioneer manufacturers of boilers designed for smokeless combustion, this firm has reached the position where its persistent policy has been more than justified. The Cripps down-draft boiler, which is the subject of this catalogue, is designed to burn soft coal of any grade with the elimination of the smoke nuisance. The fire pot, it will be noticed, occupies a position in the center of the section, operating in conjunction with the ordinary up-draft fire at the base of the boiler. By uniting the two fires, the combustion, it is stated, is practically smokeless and 90 per cent of the time with practically no smoke at all. Attention is also called to the increase in boiler efficiency offered by this construction, the grate area and actual fire surface being figured as 75 per cent more than that usually found. Price lists and capacities for all sizes are given, followed by an interesting discussion on "Chimneys vs. Combustion."

THE TELETHERM, described as something every school building should have, is a product of the American Teletherm Co., Toledo, O., which is shown in a recently issued catalogue. The teletherm is an instrument connected by means of electric wires to electric contact thermometers in each school room, and is designed to transmit to the janitor the exact temperatures of the rooms. The instrument is placed in the basement conveniently close to the heating apparatus, and at regular intervals the janitor is expected to take a reading of the temperature of each room. He does this by pushing the buttons in turn as they correspond with the various rooms. The temperature of each room is indicated by the arrow on the dial of the instrument and a permanent record is made on the chart provided for that purpose. Thus the janitor has possession of the information necessary to regulate the flow of air to the different rooms at the required temperature. In connection with the use of the teletherm there is provided a system of mixing dampers for equalizing the heat supply from one central point. The instrument is also described as a fuel-saver in preventing waste due to overheated rooms.

New Book.

HEATING AND VENTILATION, by Louis Allen Harding, B.S., M.E., and Arthur Cutts Willard, S.B., is the title of an important new work for engineers and architects, comprising Volume 1 of what will be a series of volumes on "Mechanical Equipment of Buildings." The work, however, is complete in itself, while Vols. 2 and 3, now in preparation, will deal with power plants, elevator, lighting systems, refrigeration plants, sprinkler systems, vacuum cleaning and plumbing. In its scope and general treatment of the subject the volume on "Heating and Ventilation" easily takes rank with any of the previously-published works on the same general topic. In addition the authors have drawn freely on all available sources of information relating to this field of engineering and have made extensive use of manufacturers' data in designing the various mechanical systems or plants required in modern buildings. In this respect alone, the work represents the latest and most approved practice. Moreover the extensive training and experience of the authors have enabled them to select their data with a fine discrimination, so that the reader is really getting the accumulated notes, including much original matter, of these two engineers.

Among the many notable features of this work, special mention should be made of the number and uniform character of the illustrations, the great number of these, in many cases, requiring insert sheets to contain them all.

Unlike the ordinary manual on heating and ventilation, the volume devotes the opening chapter to physical units and measurement of heat, while the second chapter is given over to a consideration of the fundamentals of water, steam and air. The authors then take up modern heating practice in its various phases. A chapter is included on electrical heating, while another chapter gives a digest of the ventilation laws now in force. Air conditioning is given the place it deserves and central or district heating is adequately treated in a long chapter on the subject. The book contains no less than 615 pages, measuring 7 x 9¼ in. There are in all 543 illustrations. The book is handsomely bound in leather and sells for $4.00. Published by

John Wiley & Sons, New York, and may be had through the book department of THE HEATING AND VENTILATING MAGAZINE.

Business Chances.

Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, Washington, D. C., for the following-named work (drawings and specifications may be obtained from the custodian of the site or from the Supervising Architect):

Until December 22, 1916, for the construction complete of the U. S. Post Office at Bakersfield, Cal.

Until December 26, 1916, for the construction of the U. S. Post Office at Mt. Carmel, Ill.

Until December 27, 1916, for the extension, remodelling, etc., of the U. S. Post Office and Court House, at Oklahoma, Okla.

Until December 27, 1916, for the construction of the U. S. Post Office at Laconia, N. H.

Tracing a Drawing Without Tracing Cloth.

Tracing cloth is affected by the amount of moisture in the air, and for that reason it is occasionally desirable to transfer a drawing to ordinary paper. This may be accomplished by the use of a glass top table beneath which are suspended several strong (60 to 100-watt) incandescent electric lamps. The strong light passes through the drawing and the superimposed paper on which the tracing is to be made. Where blueprints are desired a thin white paper can thus be used instead of tracing cloth and at less expense.

Open Window Day in New York.

The New York City Department of Health has begun a campaign for more fresh air in sleeping rooms, incidentally combating the prejudice which, it finds, still exists against "night air." The department set December 4 as "Open Window Day" in an effort to promote a more general adoption of the practice.

Lloyd W. Young, for several years advertising manager for the Bishop-Babcock-Becker Co., Cleveland, O., has resigned to engage in the advertising business under his own name, as an "advertising counselor." Mr. Young has taken offices in the 1900 Euclid Building, Cleveland.

ADVERTISERS' INDEX

Air Moistener Co., The 76
American District Steam Co. 81
American Blower Co. 73
American Radiator Co. .....Back Cover
Badger & Sons Co., E. B. .....Third Cover
Bayley Mfg. Co. .....Second Cover
Bicalky Fan Co. 16
Bishop-Babcock-Becker Co. 64
Bristol Co., The .....Front Cover
Buffalo Steam Pump Co. 8
Carrier Engineering Corporation 66
Connersville Blower Co. 3
Dahlquist Mfg. Co. 63
Davis Regulator Co., G. M. 82
Detroit Lubricator Co. 67
Dole Valve Co. .....Front Cover
Dunham Co., C. A. 16
Economy Pumping Machinery Co. 74
Foster Engineering Co. 6
Foxboro Co., The 65
Fulton Co., The 4
Gurney Heater Mfg. Co. .....Front Cover
Hornung, J. C. 81
Houghton & Co., E. F. 5
Ilg Electric Ventilating Co. 68
Jenkins Bros. 65
Johns-Manville Co., H. W. 73
Johnson Service Co. .....Second Cover
Knowles Mushroom Ventilator Co., Front Cover
Lavigne Mfg. Co. 8
Marsh Co., Jas. P. 3
Mason Regulator Co. .....Front Cover
Mueller Mfg. Co., H. 7
Nash Engineering Co. 14
National Regulator Co. 6
National Tube Co. 9
Powers Regulator Co. 14
Patterson & Co., Frank 70
Ric-Wil Co. 79
Ross Valve Mfg. Co. .....Front Cover
Sarco Company, Inc. 78
Sims Co., The 82
Spencer Turbine Cleaner Co. 66
Sprague Electric Works 80
Standard Thermometer Co. 70
Standard Wood Pipe Co. 79
Sturtevant Co., B. F., ...69, 71, 72 and 76
Syracuse Faucet & Valve Co. 7
Taylor Instrument Companies 66
United Vacuum Appliance Co. 80
Webster & Co., Warren 78
Westinghouse Electric & Mfg. Co. 80

TRADE AND MISCELLANEOUS NOTES

Coming Events.

January 16-18, 1917.—Annual meeting of The American Society of Heating and Ventilating Engineers, in New York. Headquarters at the Engineering Societies Building, 29 West 39th Street. Secretary, C. W. Obert.

Deaths.

F. E. Cudell, a well-known architect of Cleveland, O., and the inventor of the Cudell sewer trap, died recently at his home in that city. He was a native of Germany and came to this country in 1866.

Miscellaneous Notes.

Philadelphia, Pa.—A bulletin calling attention to the perils of heat without proper ventilation has been issued by Dr. Wilmer Krusen, director of the Department of Public Health. "The ideal indoor conditions," it states, "favorable to comfort, ease and good health, are a temperature of 70° F. and a relative humidity of 65%."

L. O. Koven, of L. O. Koven & Bro., New York, who recently retired from the presidency of the Eastern Supply Association, was presented with a loving cup by friends in that association, the donors including F. S. Hanley, F. B. Maerkle, A. S. Mitchell, R. H. Noble, H. H. Sommer and Mr. Allart. The presentation was made by Mr. Maerkle at the Machinery Club, New York, November 10.

Building Operations for October, 1916, continue the good showing of previous months, despite the steadily-rising prices of materials. The figures for 111 cities, compiled by The American Contractor, Chicago, show a total of $86,128,865 as compared with $67,882,891 for the previous October. This represents an increase of 27%. Among the more important gains are: Cleveland 70%, Columbus 47%, Boston 56%, Denver 44%, Detroit 120%, Erie 261%, Los Angeles 79%, Milwaukee 157%, Nashville 192%, New York 27% ($13,377,672 as compared with $10,527,006), Philadelphia 36%, Rochester 31%, Seattle 243%, St. Louis 10%. Losses were reported as follows: Chicago 8% ($11,408,300 as compared with $12,479,250), Kansas City, Mo., 28%, Minneapolis 38%, Pittsburgh 31% San Francisco 18%, Washington 18%.

Central Supply Association has issued a "souvenir review" of its history of 21 years. It is a handsomely-printed booklet of 28 pages embellished with full-page photographic reproductions of its present and past presidents, and other officers. This association was organized in Chicago in 1884, succeeding in certain of its activities the National Association of Jobbers of Plumbers', Gas and Steamfitters' Supplies. The association has always taken a firm stand for the highest business standards and is responsible for many reforms which are now every-day practice in the trade. Among the subjects which early engaged the attention of the association were the matters of lump bids and estimates, boycotts, boxing and cartage as a separate item, and returned goods and breakage. As a result of the association's action on boxing

"THE DAHLQUIST"

Copper Hot Water Boilers

For Large Apartment Houses, Hotels, Hospitals, Restaurants, and Public Institutions.

Long and Reliable Service Guaranteed.

Engineers recognize the high character of our product by specifying "The Dahlquist Boilers" on their most exacting work. **Write for catalogues**

DAHLQUIST MFG. CO., 40 West 3rd Street, BOSTON, MASS.

and cartage it is stated that the membership has benefited to the extent of $4,5000,000. At the 1894 meeting was inaugurated the credit system which in the succeeding twenty-two years has shown: number of claims, 44,000; amount of claims, $4,571,180; collections through the secretary's office, $2,837,546; claims paid on Form No. 1, of which the association has no accurate record, approximately $11,350,184. At the St. Louis meeting, in 1895, the first step was taken towards standardization of fixtures when resolutions were passed concerning selling irresponsible plumbers on owners' or architects' guarantees. The membership of the association, which began in 1894 with 32, reached in October, 1915, 234 regular members and 124 branch houses.

Central Station Heating Notes.

Des Moines, Ia.—A movement is on foot in Des Moines to revive the question of a central heating plant for that city. The proposition was unofficially approved by the town planning commission at one of its recent meetings and a petition will soon be circulated in the business district asking the city council to resubmit the question. It will be recalled that the Des Moines Electric Company sought a franchise for a heating system in Des Moines last spring. The project was favored by the city council, but on a referendum vote, taken March 27, it was rejected by the voters. The granting of the franchise was opposed by the Labor League of Des Moines.

Sibley, Ia.—The new Sibley steam heating plant, which has just begun operations, has already arranged to supply twenty-three business houses with steam for heating. Steam is being sold on a meter basis. Superintendent Kahlert states that the exhaust steam from the power house engines will probably be sufficient to meet present requirements. The system operates with vacuum pumps, with the steam pipes varying in size from 10 to 6 in. diameter, and the return pipes from 4 to 2½ in. The supply mains are insulated with expanded asbestos pipe covering 2 in. thick and recovered with a roofing jacket. The return pipes are covered with asbestos only. Both are enclosed in vitrified glazed tile. The steam pipes are supported every 12 ft. by concrete bases. The plant was installed by the Milwaukee Conduit & Insulation Co. and the steam fitting work was in the hands of G. E. G. Robb, of Minneapolis.

Mandan, N. D.—The Mandan Electric Company's heating plant, which is to serve three blocks in Mandan, from the First National Bank to the Interocean Hotel, has been completed and was to be put in operation with the opening of the heating season.

100% Efficient Heating Service

is assured if you install a

"RELIABLE" VACUUM OR VACU-VAPOR HEATING SYSTEM

HERE ARE A FEW REASONS WHY:

Even Heat Distribution, in zero or mild weather at any temperature desired.

Instant Results. Not necessary to wait until the cold air is forced out of the pipes and radiators, before heating begins.

Noiseless. No hissing radiators or hammering in the pipes.

No vapor escape.

No odors or gases.

No leaky Radiator Valves.

No adjustments necessary, as all attachments are permanently adjusted at the factory.

Great fuel Economy, because less steam pressure is required to operate system and maintain desired temperature.

Flexibility. The 3 styles of **"Reliable"** Systems—Air Line, Return Line and Vacu-Vapor—are equally efficient for large or small plants; and any style of building. Can be installed without changing piping of old systems.

These and many other advantages are thoroughly described in our "Reliable" Heating Catalog. Write for your free copy today, together with large charts showing typical layouts and styles of installation. Ask for Catalog "HV".

THE BISHOP-BABCOCK-BECKER CO. Cleveland, O.

Rock Rapids, Ia.—Work has begun on the new $25,000 public heating plant being built in Rock Rapids.

Iowa Falls, Ia.—The courts may be called on to decide whether or not the Iowa Falls Electric Company is to furnish hot water heat to patrons of the old electric light company which went out of business suddenly and left a number of customers without heat. Steps that look as though legal proceedings might ensue were taken when notices were served on the Iowa Falls company that unless it connects certain properties, the property owners will connect their buildings with the company's heating mains. Property-owners mentioned in the notice include A. J. Kennedy, J. W. Brown, O. C. Stubbs, Elwood Brogan, Mrs. M. A. Harp and Mrs. W. L. Hay. It is proposed by the petitioners to ask that the franchise of the Iowa Falls company be forfeited on the grounds of violations of the provisions of the ordinance under which the company is operating. In the meantime O. C. Stubbs has attached a large part of the visible property of the old light company with a view of collecting damages for the cutting off of the heat without warning. He states that he had a two-year contract with the old company which has not expired.

Sioux City, Ia.—A proposed ordinance is before the city council and has already been given two readings, granting the Warfield, Pratt, Howell Company the right to cross a city alley between Jones and Jennings Streets with a steam heating connection. The company is planning to furnish heat to a number of concerns, paying 2% of the gross revenue obtained to the city.

Mankato, Minn.—The Mankato, Minn., Ledger is agitating the construction of a central heating plant in Mankato, reviving a proposition that was talked of in that city a few years ago. A municipally-owned plant is proposed.

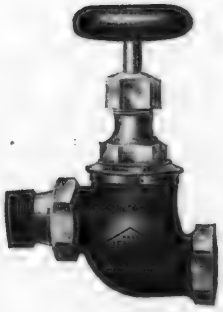
Cleveland, O.—An ordinance authorizing the transfer of about one-sixth of an acre of Wade Park property to trustees of the art museum for the erection of a small heating station, has been introduced in the city council. It is planned to locate the building immediately west of the museum.

Coeur d'Alene, Idaho.—The new plant of the Central Heating and Lighting Co., of Coeur d'Alene, which was recently granted a franchise for a central heating system, will cost $101,000, according to Frank D. Warn, one of the principal promotors of the enterprise.

Manufacturers' Notes.

Central Station Steam Co., Detroit, Mich., manufacturers of expansion joints, condensation meters, etc., for central station heating, has opened a permanent branch office in Minneapolis, Minn., in the Metropolitan Life Building. The office is in charge of W. K. Abernathy. The Central Station Steam Company has closed a contract with the Illinois Engineering Company, Chicago, to handle the sale of the Illinois company's complete line of vacuum radiator valves and other specialties in the Minnesota district.

Underground Specialties Co., 1476 Broadway, New York, has been appointed New York agent for A. Wyckoff & Son Company, Elmira, N. Y., manufacturer of the Wyckoff line of pipe coverings.



Jenkins Bros. Radiator Valves

help to make the radiator what it should be—a source of comfort. A correctly installed heating plant requires a good, substantial valve to make the system perfect. Jenkins Bros. Valves always work freely, close tight, and stay tight, because they have been built (for 50 years) to stand all reasonable service, and more than a reasonable amount of abuse.
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TO INDICATE or RECORD TEMPERATURES and PRESSURE
They have a distinctive quality with a fineness of mechanical detail which insures Accuracy and Durability under the hardest Service

THE FOXBORO COMPANY, FOXBORO, MASS.

New York Chicago St. Louis Birmingham, Ala. San Francisco

H. B. Smith Co., Westfield, Mass., announces the removal of its New York office to 10 East 39th Street, where attractive showrooms are provided for the display of the company's line of Mercer and Mills boilers and Princess radiators. J. C. Faulkner is the company's New York manager.

Goulds Mfg. Co., Seneca Falls, N. Y., announces the appointment of Robert E. Hall, vice-president of the company, as manager of the Chicago and northwestern territory. Mr. Hall will make his headquarters in Chicago, at 12 South Clinton Street.

Century Ventilating Co., New York, manufacturer of the Century line of ventilators, has moved its offices and plant to 257 Third Avenue, between 20th and 21st Streets.

American Radiator Co., Chicago, Ill., has declared a regular quarterly dividend of 1¾% on its preferred stock and a regular quarterly 4% dividend on its common stock.

AIR CONDITIONING

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Engineering Corporation

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Spencer Turbine Vacuum Cleaners

are manufactured in sizes from ¾ H. P. to 40 H. P.

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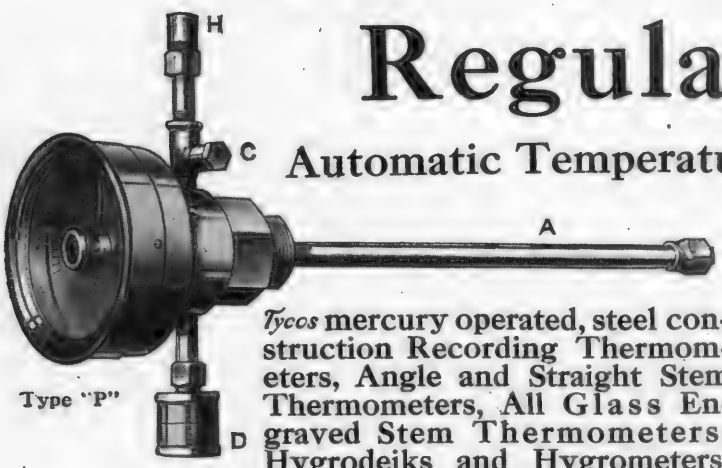
H&M Thermometers

Regulators

Automatic Temperature and Pressure



Type "P"

Tycos mercury operated, steel construction Recording Thermometers, Angle and Straight Stem Thermometers, All Glass Engraved Stem Thermometers, Hygrodeiks and Hygrometers, Thermo-Electro and Radiation Pyrometers.

Mark this: — Every Instrument bearing H & M *Tycos* makes honest claim to supremacy because every manufacturing step is carefully worked out in detail, applications carefully studied.

Put your problem up to us. Our experience will prove very valuable to you. Our service prompt and efficient, suggestions and literature free. Command us.

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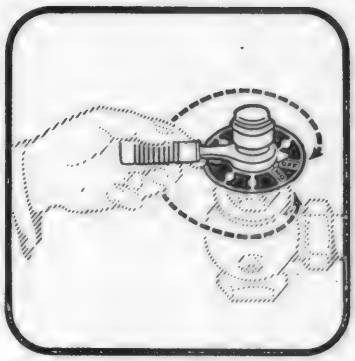
DETROIT PACKLESS RADIATOR VALVES



Announcing the
New Detroit Vacuu Valve

LESS THAN ONE TURN

Operates this Packless Valve for Vapor-Vacuum Heating Systems. Ease of operation is combined in it with effectiveness *however high the pressure.*

Specify Genuine Detroit Packless Valves

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DETROIT, U. S. A.
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LARGEST MANUFACTURERS OF RADIATOR VALVES IN THE WORLD

New Incorporations.

Washed Air Cooling-Heating-Ventilating Co., New York, capital $100,000. Incorporators: B. MacFadden, O. J. Elder, 949 Broadway, New York; and J. H. Lambert, 31 Broad St., New York.

Union Plumbing & Heating Supply Co., Boston, Mass., capital $10,000. Incorporators: George W. Ravin, Samuel H. Harris and Samuel L. Karp.

Izard-Gas Heating Co., Vancouver, B. C., capital $100,000. Incorporators: G. D. Dearlove, Frank Menefee and others.

Hoffman Heating Co., St. Louis, Mo., capital $3,000, to manufacture and deal in heating apparatus. Incorporators: John Grass, Fred Schmitt and Fred. E. Harris.

Contracts Awarded.

Smith & Wells Heating and Plumbing Co., Springfield, O., heating and ventilating new $250,000 high school building in Joplin, Mo., for $50,000.

William McArthur, Los Angeles, Cal., heating and plumbing Masonic Home at Covina for $27,000. John F. Blee, Los Angeles, is the architect.

Prox & Burkett Co., Terre Haute, heating, ventilating and plumbing new Science

ILG

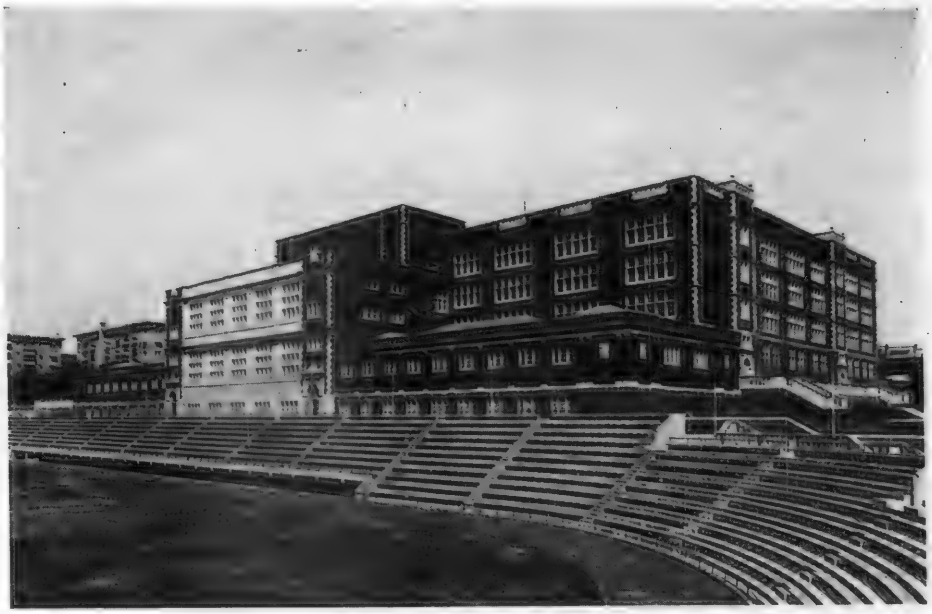
DIRECT CONNECTED BLOWERS

Compact—Efficient—Quiet Running

EASY TO INSTALL

One Nameplate, One Guarantee Covering Fan and Motor

ILG Electric Ventilating Co. 158 Whiting Street CHICAGO, ILL.



South View of the Central High School, Washington, D. C.
Architects, WM. B. ITTNER, St. Louis; SNOWDEN ASHFORD, Washington, D. C.

Sturtevant Apparatus in Washington Central High School

The Washington High School, which is considered one of the most modern and up-to-date schools in the country, has a Sturtevant Heating and Ventilating system, which includes 12 Multivane Fans.

We have recently published a new catalog on our Heaters, which contains complete information and data for Heating and Ventilating Engineers. Amongst other things it contains temperature rise tables and curves, piping diagrams, dimensions.

Copy of this new publication will be sent you on request. Ask for Catalog 230-V.

B. F. STURTEVANT COMPANY,

Hyde Park, Boston, Mass.

And All Principal Cities of the World.

Largest Manufacturers of Fans, Fan Systems and Allied Products in the World.

Hall at the Indiana State Normal School, for $20,218.

Mehring & Hanson Co., Chicago, Ill., heating new $300,000 grocery warehouse on Grand Avenue, Chicago.

Byron Heating and Ventilating Co., Toledo, O., heating and ventilating new school building at Kerwin and Warren Avenues, Detroit.

Thomas E. Hoye Heating Co., Milwaukee, Wis., heating new $700,000 building in Milwaukee for the Wisconsin Telephone Company.

Teran, Mahoney & Munro, New York, heating Westchester County Almshouse at Mount Pleasant, N. Y.

Downey Heating & Supply Co., Milwaukee, Wis., heating second unit of the new State Normal School at Oshkosh; for $10,066; the plumbing contract went to the American Heating & Supply Co., Superior, at its bid of $6,984.

Business Chances.

Washington, D. C.—Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, for the following-named work:

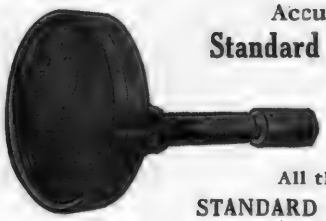
Until December 14, 1916, for the construction complete of quarantine officers' quarters at U. S. Quarantine Station, Cape Charles, Va.

Until December 22, 1916, for the construction complete of the U. S. Post Office at Dowagiac, Mich.

Until December 26, 1916, for the construction of the U. S. Post Office at Maquoketa, Ia

Until December 26, 1916, for the construction of the U. S. Post Office at Frederick, Md.

Until December 28, 1916, for the construction complete of the U. S. Post Office at Nacogdoches, Tex.



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Full line includes seven types of recording thermometers and a special line for mechanical uses

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All thermometers are double and not breakable

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THE ⌐¬ SHAPE TUBES EXPLAIN THE SUCCESS

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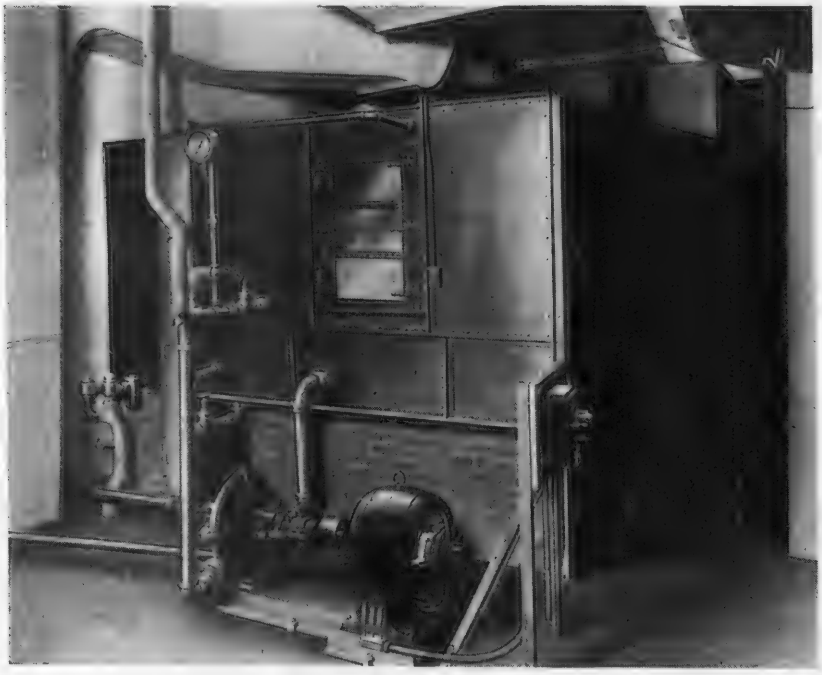

One of the Three Sturtevant Copper Air Washers in the East Ohio Gas Building, Columbus, Ohio. Building also contains Seven Sturtevant Multivane Fans. Architect, W. B. Tubby, New York; Engineer, Henry C. Meyer, Jr., New York.

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And All Principal Cities of the World.

Until January 18, 1917, for the construction of the U. S. Post Office at Marion, S. C.

Gallatin, Mo.—Park College is to have a new central heating plant which will be built on a site recently deeded to the college by Mr. and Mrs. George A. Lawrence, of Gallatin.

The Peerless Line of Down-Draft Boilers.

In a recent description, in these columns, of the Peerless line of down-draft boilers, made by the Peerless Heater Co., Pittsburgh, Pa., it was stated that the company's series (38) for steam and hot water contained nine sizes ranging from 1,650 sq. ft. steam and 2,700 sq. ft. water to 5,000 sq. ft. steam and 8,500 sq. ft. water.

In this connection the attention of our readers should be called to the fact that the company also makes another series (50) of this down-draft boiler, ranging in capacity, in water, from 5,600 to 16,000 sq. ft. and in steam, from 3,500 to 10,500 sq. ft., making the Peerless line as complete as any line of down-draft boilers manufactured.

Line of Metaphram Steam Damper Regulators Now Complete.

Announcement is made by the National Regulator Co., Chicago, Ill., that its line of Metaphram steam damper regulators is now complete. The types comprising this line are the Type A Junior, for very small boilers; Type A, for medium-sized boilers; Type B-C, for medium-sized boilers, either vapor or pressure, equipped with the adjustable fulcrum and slidable lever features; Type D or 10-in. which is not illustrated in the company's circulars, but which is designed exclusively for vapor, having but three sections 10 in. in diameter and being more sensitive than Type B-C, but having more power for the same amount of sensitiveness; Type E, which is the hot water boiler control, consisting of a simple and sensitive thermostatic device, connected by a flexible tube with a Metaphram motor, which will in turn operate the drafts; and finally Type H-P, or the high pressure type.

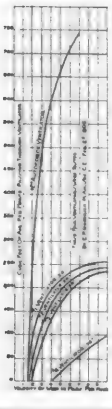
Metaphram damper regulators are described as all metal, dust-proof, compact and powerful and are remarkable for their sensitive action. They are direct-acting, requiring no auxiliary power.

Smokeless Boilers Manufactured by Utica Heater Company.

Due to an oversight the list of manufacturers of smokeless boilers, published in the October (Smokeless Boiler) Number of THE HEATING AND VENTILATING MAGAZINE, did not include the name of the Utica Heater Co., Utica, N. Y. This company, as is well-known, manufactures the Imperial line of smokeless boilers, one of which was illustrated in an article by Martin H. Rooney in THE HEATING AND VENTILATING MAGAZINE, for October, 1915.

Storage Heaters Used as Economy Coils.

Economy coils for utilizing the heat in the condensation before it is thrown away are usually in the form of indirect radiators, but a new form is brought to the attention of the trade by the Sims Co., Erie, Pa., in a statement telling of the use of the Sims steam-tube storage-type heater for this purpose. When used in this way the water in the heater absorbs the heat from the condensation and in practice the results have been found to be highly satisfactory in connection with general hot water service.



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Increasing Use of Pipe and Tubes for Various Purposes.

When the word pipe is mentioned the average person thinks of the ordinary steam or water pipe in general use, but what is not so generally known is the fact that the uses of pipe are numbered by hundreds and even thousands.

Coincident with the extended use of tubular products has been not only greatly increased tonnage, but also a change in material. Fifty years ago practically all of the screw-joint pipe was made from wrought iron, but the invention of Bessemer and the open-hearth processes of making steel have caused a decided change in the material.

In a recent statistical bulletin issued by the American Iron and Steel Institute, it was shown that the gross tons of wrought iron produced per year has not only decreased from 452,797 in 1905 to 262,198 in 1915, but at the same time the percentage of total has decreased from 31.5 in 1905 to 11.4 in 1915 and the percentage of steel has correspondingly increased.

The history of the widely ramifying uses of pipe reads almost like a romance and inasmuch as the National Tube Company has recently announced plans for building a new plant at Gary, Ind., having a capacity of 500,000 tons per year, it would appear that the uses of pipe have by no means reached their limit.

Heat Value Standards for Gas.

In answer to a question in the Gas Institute News regarding the names of foreign countries that have adopted and are now working under a heat value standard for gas, it is stated that Germany, France and Austria-Hungary have no national quality standards, but in the principal cities of these countries the gas standards are on a calorific basis. The Dominion of Canada is now operating under a national heating value regulation requiring the companies to

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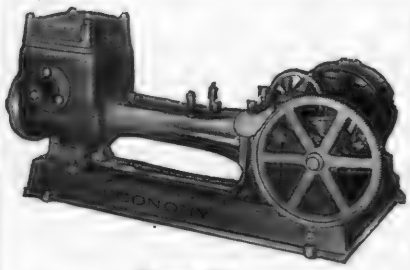

Figure 2149
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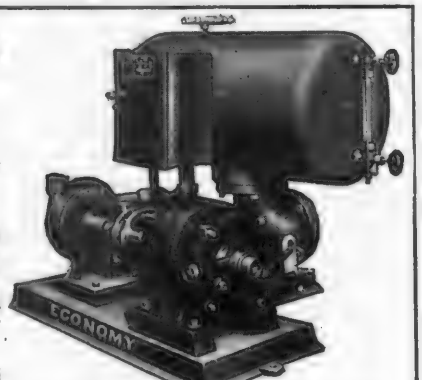

Figure 2129—Economy Automatic Condensation Pump and Receiver for low water lines and underground returns.

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supply 520 B.T.U. (total) per cubic foot at all times. This regulation was put in force July, 1915, and superseded a regulation requiring the delivery of gas under a candle-power standard. The Imperial Gas Association of Japan recommended to its government in 1915 the adoption of a gross heating value standard of 500 B.T.U. per cubic foot.

It should be noted that English gas companies hold their charters by acts of Parliament, which specify the quality standard under which the company shall operate. Since the latter part of 1913 the quality standard imposed in all cases has been a total average heating value of 540 B. T. U.

Concerning the States which have adopted a heating value standard; the "Summary of State Commission Regulations Governing Gas Supply," gives thirteen States which are operating under a heating value standard. Since that time heating value regulations have been promulgated in Connecticut, calling for a monthly average total heating value of 575 B.T.U., with an allowable daily minimum of 530 B.T.U., and in Missouri falling for a monthly average total heating value of 570 B.T.U., with an allowable daily minimum of 520 B.T.U.

It should be noted in the case of Maryland that the City of Baltimore is now operating under the same standard as the rest of the State, and that of the State of Oregon has issued a supplementary order allowing oil gas to be supplied having a monthly average total heating value of 570 B.T.U.

Open Window Classes Dropped in New Jersey School.

The report of the Montclair (N. J.) Board of Education has the following to say regarding the practice of conducting open-window classes in the Montclair schools:

"In line with advanced thought in education, Montclair continues the use of standards and efficiency tests for proving the value of its educational policy. Four years of scientific investigation and trial have proved, for instance, that in our well-ventilated school buildings the open window room, so highly lauded by theorists, offers no advantage over the regular model, and all open window classes have been discontinued."

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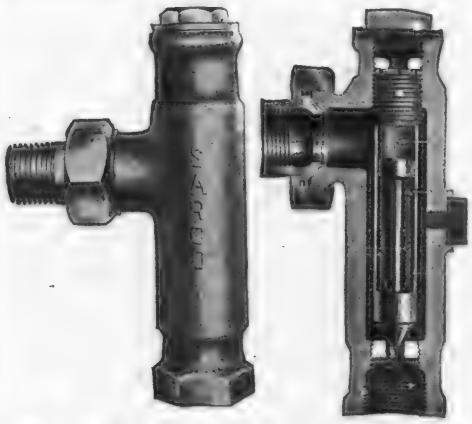

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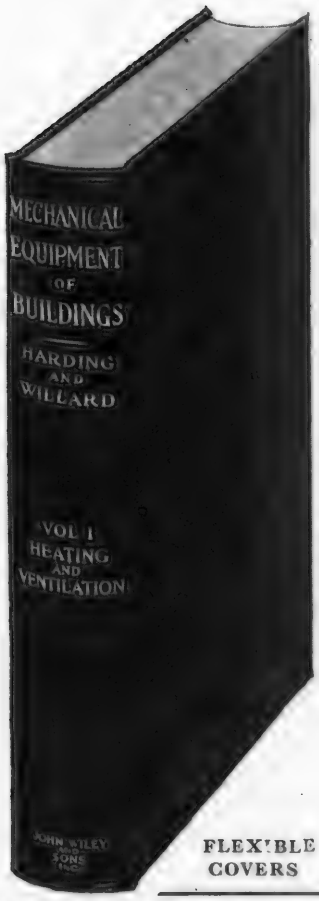

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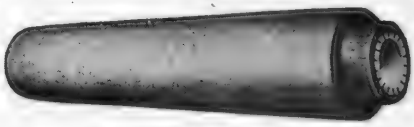

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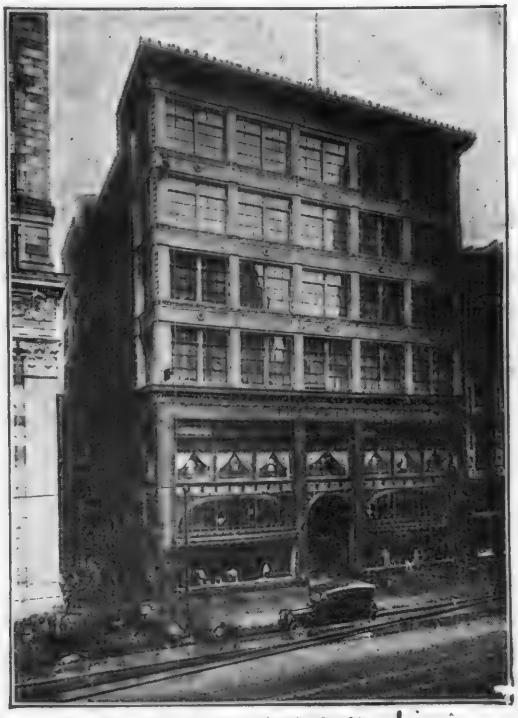

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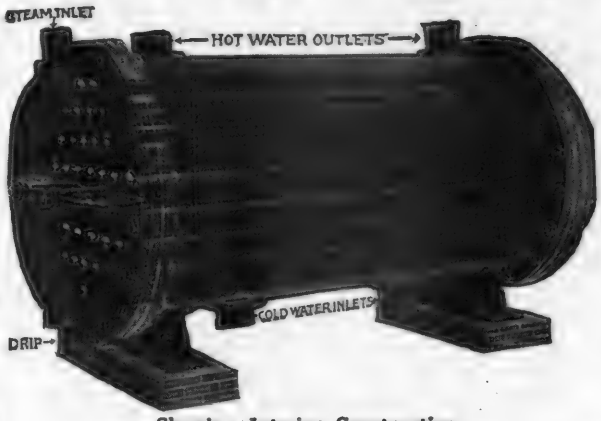

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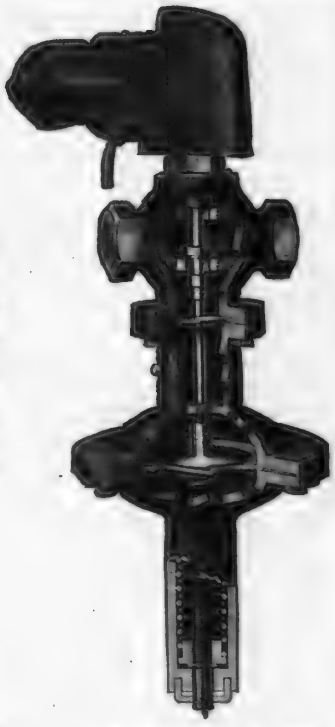

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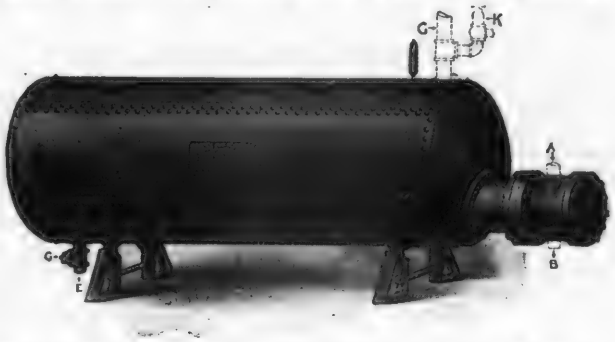

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THE HEATING AND VENTILATING MAGAZINE

Index to Volume XIII
1916

New York Heating and Ventilating Magazine Company
1123 Broadway

Accounting systems for manufacturers and retail merchants, Sept.
under municipal and private ownership, Aug.
Air breakwater, Brashear, theory of the, Nov.
conditioning in a gas mantle plant,—General Gas Mantle Co., Camden, N. J., July.
conditioning, new ideas in, W. E. Watt, Feb.
conditioning, the early history of, July.
conditions in an Illinois school, tests of, E. V. Hill, M.D., May.
contamination of, by automobile exhausts, Feb.
filters, detail of zigzag, Oct.
for steam turbine generators, washing and cooling, July.
washed recirculated air compares favorably with fresh air, Sept.
discussion of, Oct.
purification of by electricity, Dec.
weight of, and saturation curves for vapor, A. Bement, July.
Allen, John R., heat transmission through building materials, Aug.
Alt, Harold L., comparison of various methods of figuring duct and flue sizes, Oct.
humidity and automatic control, July.
natural ventilation in the Federal Hill School, June.
pipe hangers, March and April.
American Institute of Chemical Engineers, annual meeting of, Sept.
American Society of Heating and Ventilating Engineers.
New York Chapter discusses vapor and vacuum heating systems, Jan.
Illinois Chapter hears address on the use of gas for heating purposes, Jan.
Massachusetts Chapter, Jan., March, Oct., Nov.
proceedings of the twenty-second annual meeting, Feb.
new secretary for the heating engineers' society, March.
New York Chapter takes up the problem of co-operation among engineers, March.
Illinois Chapter hears lecture on fire prevention, March.
Michigan Chapter, March, May, Oct.
Ohio Chapter, March, May.
Eastern Pennsylvania Chapter organized, April.
permanent organization of Ohio Chapter, April.
car heating discussed by the Illinois Chapter, April.
March meeting of New York Chapter, April.
April meeting of Illinois Chapter, May.
Eastern Pennsylvania Chapter, May, June, Dec.
annual dinner of New York Chapter, June.
closing meeting of Illinois Chapter, June.
annual meeting of Massachusetts Chapter, June.
Michigan Chapter hears address on car heating, June.
new year book, July.
proceedings mid-summer meeting, Detroit, Mich., Aug.
Illinois Chapter, Sept.
new officers nominated, Nov.
New York Chapter, Nov.
Illinois Chapter elects officers, Nov.
New York Chapter Discusses new type of vacuum heating system, Dec.
vapor heating discussed by Illinois Chapter, Dec.
Michigan Chapter gets furnace heating data, Dec.
American Society of Mechanical Engineers, Jan., Feb., Aug.
Detroit section of, Sept.
annual meeting of, Dec.
Architect and the master steam fitter, the relations between the, D. Knickerbacker Boyd, Aug.
Atlantic City, N. J., passenger car steam heating plant at, Charles A. Bingaman, May.
Austrian engineers, the co-efficients of heat transmission established by the, A. A. Jones, Nov.

Balance, maintaining a running, in high-speed machinery, Nov.
Baldwin, William J., Jr., co-operating with the consumer, June.
Bartine, Oliver H., the building of the hospital (construction costs for 22 hospitals), July.
Bement, A., experiences with humidity, Jan.
saturation curves for vapor and weight of air, July.
Bernoulli, the principle of, and its relation to heating and ventilating of a building, S. R. Williams, Feb.
correspondence on, May.
Bingaman, Charles A., passenger car steam heating plant at Atlantic City, N. J., May.
Blower systems, National Board of Fire Underwriters adopts rules regarding installation of, April.
Boiler, directions for firing a, without making smoke, Oct.
field, recent tendencies in the smokeless, Oct.
smokeless, notes on the rise of the, Oct.
smokeless, the development of the, Charles L. Collette, Oct.
tests of a magazine steam heater, E. H. Lockwood, May.
supplementary tests of, E. H. Lockwood, Aug.
Boilers, down-draft, an arrangement for maintaining even combustion in, Charles A. Fuller, Oct.
application of gas to steam, Dec.
smokeless here to stay, Oct.
testing of house heating, L. P. Breckenridge and D. B. Prentice, Dec.
testing plant for International, March.
Boyd, D. Knickerbacker, the relations between the architect and the master steam fitter, Aug.
Brashear air breakwater, theory of the, Nov.
Breckenridge, L. P. and D. B. Prentice, the testing of house heating boilers, Dec.
Building, advantages of winter, Jan.
materials, effect of velocity and humidity of air on heat transmission through, J. A. Moyer, Feb.

materials, heat transmission through, John R. Allen, Aug.
Burley, Idaho—electric heating for a large high school, Jan.
Bushnell, S. Morgan, heating a Chicago office building, Feb.
Business outlook, the, Frank M. Huston, Feb., March, April, July and Aug.

Car heating—passenger car heating plant at Atlantic City, N. J., Charles A. Bingaman, May.
Central station heating—co-operating with the consumer, William J. Baldwin, Jr., June.
—cost of removing and replacing pavement incidental to the installing of heating lines in city streets, W. F. Verner, May.
correspondence on, July.
in Wadena, Minn., L. A. Larsen, May.
public service commission rulings on, Nov.
the method of the future, Arthur Williams, Aug.
—three municipal heating plants built during 1915, Jan.
Central station steam service in New York, important extension of, New York Steam Co., July.
steam service, new rate system for, Nov.
Chicago office building, heating a, S. Morgan Bushnell, Feb.
schools, ventilation of, March.
Chimneys, taking cinders and dust from the gases in, July.
things to remember about, E. C. Molby, Oct.
Coal, burning soft coal without smoke; also combustion of coals in general, Frederick T. Oakes, C.E., Oct.
Collette, Charles L., the development of the smokeless boiler, Oct.
Consulting Engineer, the,
56—points in forced hot water heating work, Jan.
57—data for figuring an indoor plunge, Jan.
58—water troubles in steam radiators, Jan.
59—recent data on the recirculation of air, March.
60—radiation supplied by different-sized steam lines, April.
61—figuring capacity of vacuum pump, May.
62—a vapor job that gives trouble, May.
63—what is the best type of heating system? Aug.
relative capacity of steam and hot water to carry heat, Sept.
64—heating costs for dwellings, Sept.
65—the economy of superheated steam, Oct.
66—heating with exhaust steam from steam hammers, Nov.
67—figuring heat output of copper coil heaters, Nov.
68—A problem in handling condensation, Dec.
69—Waste pipes for corrosive acids, Dec.
Co-operating with the consumer, William J. Baldwin, Jr., June.
Co-operation, for close, between the manufacturers and contractors of heating apparatus, Frederick W. Herendeen, Aug.
Correspondence.
contractor's guarantee of heating installations, Jan.
simple remedy for noisy heating systems, April
relation of Bernoulli theorem to heating and ventilating work, May.
proposed compulsory requirements for natural and mechanical ventilation of school buildings, May.
the danger of excessive humidity in the air supply, July.
cost of removing and replacing pavements, July.
contractor's guarantee for heating system, Aug.
capacity of fans to carry saturated air, Aug., Sept. and Oct.
the smokeless boiler number, Nov.
figuring duct and flue sizes, Nov.
heating with exhaust steam from steam hammers, Dec.
Cost of operating electric fan over radiator, Feb.
of removing and replacing pavements incident to the installation of heating lines in city streets, W. F. Verner, May.
correspondence on, July.
Costs, construction, for twenty-two hospitals—the building of the hospital, Oliver H. Bartine, July.
operating, of steam and furnace heating plants, Jan.
operating, in thirteen school buildings—Jamestown, N. Y., J. M. Cushman, Nov.
Cushman, J. M., a survey of operating costs in thirteen school buildings—Jamestown, N. Y., Nov.

Drips on steam piping, Nov.
Duct and flue sizes, comparison of various methods of figuring, Harold L. Alt, Oct.
Ducts, correct and incorrect methods of connecting branches to main, Feb.
pipes or, area of cylindrical, Nov.
ventilating, chart for figuring round and rectangular, Charles A. Fuller, Aug.

Electric heating for a large high school, Burley, Idaho, Jan.
Electricity, purification of air by, Dec.
Engineer, American, a character study of the, May.
Engineering profession in the United States, what can best be done to advance the interests of, J. A. L. Waddell, Nov.
Engineers, co-operation programme for, June.
how can, best utilize technical journals, Feb.
in get-together movement, May.

Fan foundations, for noiseless operation, Sept.
Federal Hill School, natural ventilation in the, Harold L. Alt, June.
Fee-plus-cost system of charging for professional service, the, William Stanley Parker, Sept.
Flue sizes, comparison of various methods of figuring duct and, Harold L. Alt, Oct.
Fuel burning reports, June.
Fuller, Charles A., an arrangement for maintaining even combustion in down-draft boilers, Oct.
chart for figuring round and rectangular ventilating ducts, Aug.
Furnace design, smokeless, some elements of, Osborn Monnett, Jan.
heating plants, operating cost of steam and, Jan.
publicity campaign, the warm-air, June.
trade stirred by university booklet on house heating, Sept.
warm-air, more publicity for, July.
Gas, application of, to steam boilers, Dec.
Gas house heating, F. R. Hutchinson, March.
mantle plant, air conditioning in a—General Gas Mantle Co., Camden, N. J., July.
sewer, heat from, April.
Gases, flue, sampling and analyzing, Feb.
in chimneys, taking cinders and dust from the, July.
General Gas Mantle Co., Camden, N. J.—air conditioning in a gas mantle plant, July.
Generators, steam turbine, washing and cooling air for, July.
Greenhouse heating—heating a conservatory and greenhouse, J. D. Hoffman, Sept.
Gurney, Edward, death of, Oct.

Heat from sewer gas, April.
insulating properties of commercial steam pipe coverings, the, L. M. McMillan, Jan.
losses, new apparatus for testing, March.
transmission from radiators, apparatus for testing, May.
transmission, government experiments on, through walls, Sept.
transmission, the co-efficients of, established by the Austrian engineers, A. A. Jones, Nov.
transmission through building materials, John R. Allen, Aug.
transmission through building materials, effect of velocity and humidity of air on, J. A. Moyer, Feb.
transmission through various types of sash, Arthur N. Sheldon, Dec.
Heater, tests of a magazine steam, E. H. Lockwood, May.
supplementary tests of a magazine, E. H. Lockwood, Aug.
Heaters, comparative tests of water, Jan.
Heating a Chicago office building, S. Morgan Bushnell, Feb.
a conservatory and greenhouse, J. D. Hoffman, Sept.
and ventilating, an example of unit classroom, June.
and ventilating of a building, the principle of Bernoulli and its relation to, S. R. Williams, Feb.

correspondence on, May.
and ventilating requirements for public school buildings in Illinois, new, Feb.
and ventilating requirements, notes on compulsory, May.
and ventilating work, British standards for, April.
and ventilating laws, requirements for model compulsory, April.
and ventilation, newly-collected data on, Edward B. Johnson, Nov.
—automobile 'busses to be heated, March.
buildings, the comparative effects of wind and sunshine on, Donald B. Prentice, June.
efficient, for institutional groups, Albert L. Baum, Nov.
electric, for a large high school—Burley, Idaho, Jan.
fuel economies in house, H. R. Johnson, Dec.
hot water, for a railroad station in a cold climate—Pocatello, Idaho, Aug.
hot water, new empirical formulae for, Jay H. Keller, March.
house, by gas, F. R. Hutchinson, March.
installations, talking points for better, Feb.
needs in China, April.
plant at Atlantic City, N. J., passenger car steam, Charles A. Bingaman, May.
plants built during 1915, three municipal, Jan.
plants, determination of radiator sizes for hot water, Freywid Wegelius, Jan., April.
plants, operating costs of steam and furnace, Jan.
systems, expansion tank data for hot water, Feb.
Herendeen, Frederick W., for closer co-operation between the manufacturers and contractors of heating apparatus, Aug.
Hill, E. V., M.D., tests of air conditions in an Illinois school, May.
Hoffman, J. D., heating a conservatory and greenhouse, Sept.
Hospital, the building of the—construction costs for twenty-two hospitals, Oliver H. Bartine, July.
Huston, Frank M., the business outlook, Feb., March, April, July, Aug.
Humidity and automatic control, Harold L. Alt, July.
and its measurement, Kenneth G. Smith, March.
a correction, May.
experiments with, A. Bement, Jan.
of air on heat transmission through building materials, effect of velocity and, J. A. Moyer, Feb.
readings, the government's publication of midday, Feb.
simple directions for measuring, July.
Hutchinson, F. R., house heating by gas, March.

Institution (British) of Heating and Ventilating Engineers, Mar., Nov.
no summer meeting of, July.

Jamestown, N. Y.—a survey of operating costs in thirteen school buildings J. M. Cushman, Nov.
Johnson, Edward B., newly-collected data on heating and ventilation, Nov.
Johnson, H. R., fuel economies in house heating, Dec.
Jones, A. A., the co-efficients of heat transmission established by the Austrian engineers, Nov.

Keller, Jay H., new empirical formulae for hot water heating, March.

Larsen, L. A., central station heating in Wadena, Minn., May.
Laws—new heating and ventilating requirements for public school buildings in Illinois, Feb.
—notes on compulsory heating and ventilating requirements, May.
requirements for model compulsory heating and ventilation, April.
Leakage, window, Stephen Voorhees and Henry C. Meyer, Jr., April.
Legal decisions.
heating rates—factors to be considered, Jan.
infringement of furnace regulator patent—preliminary injunction, Jan.
ventilation of street cars, Jan.
assignability of heating contract, Feb.
failure to heat premises—tenant's remedy, Feb.
contract for sale of ventilating fan—rescission, Feb.
fumes from gas water heater, Feb.
when a contract is binding, despite the use of a printed clause on business stationery, March.
payment for additional radiation, March.
draft regulator for furnaces, March.
steam heating properties, May.
agency for wife in contracting for heating installation, May.
damage to boiler shipped—evidence, May.
tax on central steam heating companies, June.
defective steam heating plant—waiver by tenant, June.
where heating plant is not a trade fixture, June.
apportionment of mechanic's lien among several houses, Aug.
action on installation contract, Aug.
duty of purchaser of plant to minimize damages from defects, Aug.
right to lien for heating plant, Aug.
discontinuance of heating service on operation at loss, Sept.
building ventilation regulations, Sept.
discriminative taxation of heating company, Oct.
heating radiation as "fixtures," Oct.
damages for owner's breach of installation contract, Oct.
time for filing mechanic's lien, Oct.
heating and ventilating employee sues general contractors, Oct.
"doing business" in State, Dec.
rates for domestic heating appliances, Dec.
reasonable rates for heating service, Dec.
application of money derived from contract, Dec.
Lockwood, tests of a magazine steam heater, May.
supplementary tests of, Aug.

McCann, Frank G., New York school heating practice, Sept.
McMillan, L. M., the heat insulating properties of commercial steam pipe coverings, Jan.
Meyer, Jr., Henry C., and Stephen Voorhees, window leakage, April.
Molby, E. C., things to remember about chimneys, Oct.
Monnett, Osborn, smoke prevention codes for large and small cities, Oct.
some elements of smokeless furnace design, Jan.
Motion picture houses in New York City inadequately ventilated, May.
Motors, speed control of direct-current, for ventilating service, B. K. Strader, Dec.
Moyer, J. A., effect of velocity and humidity of air on heat transmission through building materials, Feb.

National Association of Master Steam and Hot Water Fitters, March, April, May, June, July, Sept.
annual convention of, July.
report of standardization committee, Sept.
master steam fitters for arbitration in labor disputes, Nov.
National Board of Fire Underwriters adopts rules regarding installation of blower systems, April.
National District Heating Association.
arrangements for eighth annual convention, May.
entertainment programme, May.
proceedings eight annual convention, June.
plans for 1917 convention, Nov.
meeting of research committee, Nov.
dates selected for 1917 convention, Dec.
New Books.
the ventilation handbook, Charles L. Hubbard, March.
practical sheet metal duct construction, William Neubecker, July.
B.T.U. manual for estimating steam and water radiation, Sept.
correction of echoes and reverberation in the auditorium, University of Illinois, Sept.
the engineer in war, Major P. S. Pond, Oct.
power for profit, Reginald Pelham Bolton, Oct.
how to build up furnace efficiency, Joseph W. Hays, Nov.
heating and ventilation, Harding and Willard, Dec.
New York Public Library, municipal reference branch, articles from trade papers now catalogued by the, April.
school heating practice, Frank G. McCann, Sept.
School of Heating and Ventilation, holds fourth annual dinner, April.
School of Heating and Ventilation preparing for Fall season, Sept.

State Commission on Ventilation, papers published by the, July.
Steam Company—important extension of central station steam service in New York City, July.

Oakes, Frederick T., C. E., burning soft coal without smoke; also combustion of coals in general, Oct.
Ohio Society of Mechanical Electrical and Steam Engineers, annual meeting of, Oct.
Operating cost in thirteen school buildings, a survey of—Jamestown, N. Y., J. M. Cushman, Nov.
costs of steam and furnace heating plants, Jan.
Overhead expense, items to be considered in figuring, Sept.

Pipe, American, a British tribute to the superiority of, Oct.
coils, expansion of, and length of spring pieces, March.
covering, spun glass as a, Aug.
coverings, the heat insulating properties of commercial steam, L. M. McMillan, Jan.
hangers, Harold L. Alt, March, April.
symbol chart, T. W. Reynolds, Feb.
or ducts, area of cylindrical, Nov.
Piping, drips on, Nov.
Prentice, Donald B., the comparative effects of wind and sunshine on heating buildings, June.
and L. P. Breckenridge, the testing of house heating boilers, Dec.
Psychrometric tables and chart, new, July.
Public service commission rulings on central station heating, Nov.

Radiating surface required to heat water in tanks, June.
Radiator in a room, best position for a, Sept.
sizes for hot water heating plants, determination of, Freywid Wegelius, Jan., April.
Radiators, apparatus for testing heat transmission from, May.
Rate system, new, for central station steam service, Nov.
Reynolds, T. W., pipe symbol chart, Feb.
standard practice in sheet metal work for ventilating systems, Dec.
Rooney, Martin A., what is satisfactory smoke abatement? Oct.

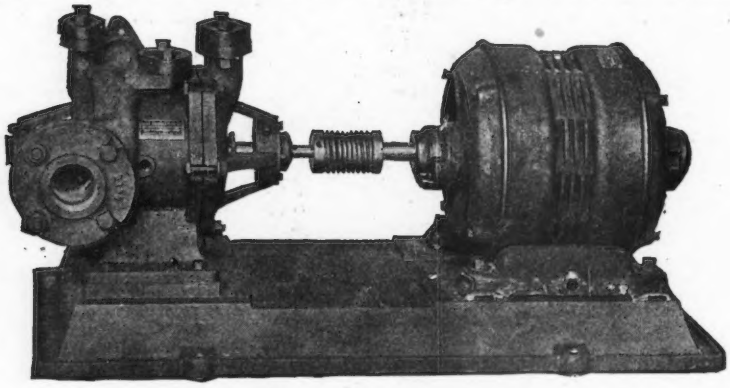
Saturation curves for vapor and weight of air, A. Bement, July.
School buildings, a survey of operating costs in thirteen—Jamestown, N. Y., J. M. Cushman, Nov.
building, electric heating for a large—Burley, Idaho, Jan.
heating—an example of unit classroom heating and ventilating, June.
heating and ventilation—washed recirculated air compares favorably with fresh air, Sept.
discussion of, Oct.
heating practice, New York, Frank G. McCann, Sept.
public, buildings in Illinois, new heating and ventilating requirements for, Feb.
tests of air conditions in an Illinois, E. V. Hill, M.D., May.
Schools, Chicago, ventilation of, March.
Sheldon, Arthur N., heat transmission through various types of sash, Dec.
Smith, Kenneth G., humidity and its measurement, March.
Smoke abatement, what is satisfactory? Martin A. Rooney, Oct.
burning soft coal without smoke; also combustion of coals in general, Frederick T. Oakes, C.E., Oct.
—directions for firing a boiler without making smoke, Oct.
prevention codes for large and small cities, Osborn Monnett, Oct.
Smokeless boiler, notes on the rise of the, Oct.
boiler, the development of the, Charles L. Collette, Oct.
boilers, firms now manufacturing, Oct.
boilers here to stay, Oct.
furnace design, some elements of, Osborn Monnett, Jan.
Steam and furnace heating plants, operating costs of, Jan.
heating plant, passenger car, at Atlantic City, N. J., Charles A. Bingaman, May.
pipe coverings, the heat insulating properties of commercial, L. M. McMillan, Jan.
turbine generators, washing and cooling air for, July.
Strader, B. K., speed control of direct-current motors in ventilating service, Dec.

Tanks, radiating surface required to heat water in, June.
Technical articles, Industrial Arts index of, May.
journals, how can engineers best utilize the? Feb.
Test of water heaters, comparative, Jan.
Testing heat losses, new apparatus for, March.
heat transmission from radiators, apparatus for, May.
of house heating boilers, the, L. P. Breckenridge and D. B. Prentice, Dec.
plant for International boilers, March.
Tests of a magazine steam heater, E. H. Lockwood, May.
supplementary of a magazine heater, E. H. Lockwood, Aug.
of air conditions in an Illinois school, E. V. Hill, M.D., May.
Threads, standard special, for fixtures and fittings, June.
Trade press, government co-operation with the, May.
Transmission of heat through walls, government experiments on the, Sept.

Valves—how often will a regrinding valve open and close? Aug.
Vapor, saturation curves for, and weight of air, A. Bement, July.
Ventilating ducts, chart for figuring round and rectangular, Charles A. Fuller, Aug.
of a building, the principle of Bernoulli and its relation to heating and, S. R. Williams, Feb.
correspondence on, May.
requirements for public school buildings in Illinois, new heating and, Feb.
requirements, notes on compulsory heating and, May.
service, speed control of direct-current motors in, B. K. Strader, Dec.
systems, standard practice for sheet metal work in standard, T. W. Reynolds, Dec.
work, British standards for heating and, April.
Ventilation gratings disapproved, sidewalk, April.
gratings, sidewalk, on Broadway, New York, barred, July.
laws, requirements for model compulsory heating and, April.
—motion picture houses in New York City inadequately ventilated, May.
natural, in the Federal Hill School, Harold L. Alt, June.
of Chicago schools, March.
Vent hoods of the internal cone type, Dec.
Vento stack casings, indirect, Sept.
staggering of, Sept.
Verner, W. F., cost of removing and replacing pavements incident to the installation of heating lines in city streets, May.
Voorhees, Stephen and Henry C. Meyer, Jr., window leakage, April.

Waddell, J. A. L., what can best be done to advance the interests of the engineering profession in the United States? Nov.
Water heaters, comparative tests of, Jan.
hot, heating plants, determination of radiator sizes for, Freywid Wegelius, Jan., April.
Watt, W. E., new ideas in air conditioning, Feb.
Weather Charts for New York, Boston, Pittsburgh, Chicago and St. Louis, Jan., Feb., March, April, May, June, Dec.
Wegelius, Freywid, determination of radiator sizes for hot water heating plants, Jan., April.
Williams, Arthur, central station heating the method of the future, Aug.
Williams, S. R., the principle of Bernoulli and its relation to heating and ventilating of a building, Feb.
correspondence on, May.
Wind and sunshine, comparative effects of, on heating large buildings, Donald B. Prentice, June.
Window leakage, Stephen Voorhees and Henry C. Meyer, Jr., April.
Windows—heat transmission through various types of sash, Arthur N. Sheldon, Dec.

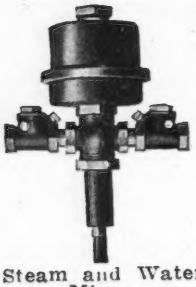
Nash Hydro Turbine Return Line Vacuum Pumps Require Only Half the Horse Power Usually Necessary



Size C, Capacity 19 cu. ft. air and 35 gallons of water per minute, delivered against 10″ of vacuum and 10 lbs. pressure, direct connected to 2 HP. motor.

Write for full information.

Nash Engineering Company, South Norwalk, Conn. U. S. A.



Steam and Water Mixer. Bulletin 137.

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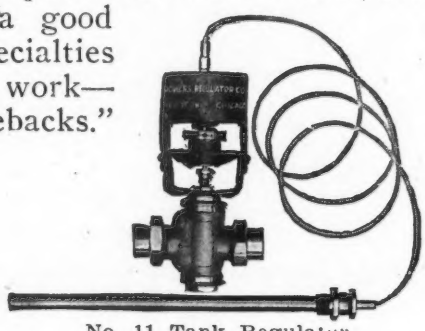

No. 11 Tank Regulator. Bulletin 129.

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